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ATOMIC ENERGY ACT – 1954

Counterforce and Damage-Limiting Capability in Central War, 1970 (U)

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SUMMARY

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The counterforce capabilities of programmed U.S. missiles and bombers are sufficient to destroy a large fraction of the fixed base Soviet missiles of Posture I on relatively conservative assumptions. The need to rely on the capabilities of

the bombers calls into question the timing of the attack. Even a substantial increase in the programmed U.S. missile force is insufficient to prevent the survival of substantial numbers of hard Soviet missiles after the U.S. missile attack. But with the possibility of large numbers of Soviet submarine launched missiles (SLMs) at sea. even high counterforce effectiveness against land-based missiles may leave the Soviet damage potential quite high. The effects of an airborne defense against SLMs and of terminal defense against ballistic missiles are considred. together with more ambitious civil defense programs. illustrating the complementarity of the various means to limit damage.

Soviet posture II incorporates harder missiles than posture I. The analysis of this case also takes a more realistic view of the problem of attacking hard targets than in the case of posture I. The additional hardness and dispersal of posture II. together with explicit concern for the uncertainties in attacking hard targets suggest that programmed offensive forces and even substantially larger missile forces would be inadequate to achieve high counterforce effectiveness against such a posture. The report considers a number of improvements in our offensive forces to eliminate the counterforce deficiencies. These include missile reliability monitoring and enhanced retargeting capability. greater payload flexibility for our missiles. a "recce-strike" modification to the B-52s (including a high resolution sensor and a small. short range. highly accurate air-to-surface missile). improved postattack recovery capabilites for the bombers. and. by way of illustration. a thermonuclear land mine for use as a missile-delivered pin down weapon for use against Soviet hard missiles. The combination of improved offense and defense capabilities offers substantial promise for reduction of Soviet damage potential in a U.S.-initiated counterforce strike against Soviet posture II: and can be accomplished without significant increase from present levels in the budgets for Packages I and II and civil defense.

No calculations are shown for posture III. As defined. this posture would permit the Soviets to retain a large damage potential against the United States. in the face of counterforce attacks and defensive efforts with U.S. weapons that are likely to be available in the early seventies. The likelihood that the Russians will develop such a posture by 1970 is not great enough to warrant current despair about the efficacy of U.S. damage-limiting measures. Moreover. much of the invulnerability of posture III is derived from systems that are attractive in concept but have never been built, operated, or subjected in concrete detail to the attentions of an opposing military planner.

In sum, it is concluded that the continued pursuit of U.S. strategic superiority is not inevitably doomed to failure. This effort cannot restore a situation equivalent to the nuclear monopoly we once enjoyed, but a lesser capability has seemed a stabilizing factor in recent crises. It may be that these crises could have been handled satisfactorily in the absence of U.S. strategic superiority: but we know of no evidence to prove this. The future would provide ample opportunity if we wished to experiment by discarding our superiority. The effects of such tests, if unfavorable, would not be easily reversible. And the experiment is not inevitable. Our analysis suggests that the United States can preserve a significant measure of superiority in a variety of likely future situations. In this respect, the results are relevant to policy decisions on the objectives and composition of our strategic forces. However, the scope of this report is insufficient to

(a) determine the preferred budget allocation:
(b) choose between emphasizing limited or general war capability: or
(c) choose between emphasizing secure retaliatory capability or capability to reduce Soviet damage potential.

To indicate preferred choices in these matters, it would at least be necessary to consider and evaluate the performance of our limited war forces. In addition, the choice is affected by the over-all defense budget, by the estimates of risks we are unable to quantify (such as the risk of escalation of limited war, or of abandonment of restraint in general war), and by an evaluation of what might constitute tolerable levels of damage in our eyes and in those of the Russians.

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PREFACE

THIS REPORT summarizes some of the research done in RAND's Alternative Central War Strategies (ACWS) project, which is a part of a continuing program of studies on strategic objectives conducted by RAND under Air Force sponsorship. The ACWS project (1) relates various broad strategic concepts with the U.S. force structure programs, war plans, and declaratory policies necessary to implement them over the next 10 years, and (2) compares these concepts in the context of a variety of Soviet strategic objectives and postures.

This report considers the future U.S.-USSR strategic balance on the assumption that the United States attempts to maintain superiority in strategic offensive capabilities. The principal substantive concern of this report is the extent to which this attempt can succeed against Soviet postures that are plausible extrapolations of current Soviet posture. The effects of variations in the objectives, budgets, and degree of bureaucratic efficiency of both sides have been the subject of RAND memoranda reporting results of the Alternative Central War Strategies project. (A bibliography of RAND literature is included at the end of this report.) The SAFE Game has been used to explore the effects of these variations on the R&D, procurement, deployment, and strike planning decisions of both sides, over a ten-year period. Six distinct cases have been documented in RAND memoranda, covering a range of U.S. objectives, from second-strike punitive capability only, to a "splendid" first-strike capability; and a range of budgets, from well below current rates of spending, to a level about three times as high as the current rate. A similar range of variation in Soviet objectives and budgets is covered in the six cases. A crude evaluation of the performance of the resulting postures in wars occurring at various times and under various contingencies of outbreak is furnished in each memorandum to provide some insight into the extent to which the stated objectives are achieved.

Much of the material in this report was presented orally to the RAND Air Force Advisory Group in April 1963 (and subsequently to the RAND Board of Trustees) as part of a series of talks on strategic issues. Members of the Air Force Advisory Group asked to see a written version, and it is partly to fulfill their request that this report is issued in this form at the present time. For the part of the ACWS project that it covers this may be considered a final documentation.

The data on U.S. programs and intelligence estimates of Soviet forces were those available early in 1963. No attempt has been made to incorporate subsequent changes.

The report has drawn heavily on past RAND work on strategic objectives, particularly that of Albert Wohlstetter, Herman Kahn, and William W. Kaufmann. Both the substance and organization of the report have benefited from the contributions of Daniel Ellsberg. RAND's investigation of the historical development of Soviet strategic posture has greatly influenced the approach adopted here, and this influence extends well beyond the section contributed by Andrew W. Marshall. The authors have received help throughout from many other colleagues at RAND, among whom Michael Arnsten, Thomas Brown, Norton D. Cohen, Ted B. Garber, Richard Kao, Roger Levien, Mary Jane Penzo, and Tracy Rumford should be particularly mentioned. Useful comments on an earlier version of this work were received from RAND colleagues John L. Bower, Bernard Brodie, Seyom Brown, Claude R. Culp, Don Emerson, James R. Schlesinger, and Vincent Taylor; and from Brigadier General G. A. Kent, DDR&E, Department of Defense. Responsibility for the text rests solely with the authors.

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I. INTRODUCTION

IS STRATEGIC SYMMETRY INEVITABLE?

THE U. S. MONOPOLY of nuclear weapons technology and their long-range means of delivery is a thing of the past. Contrary to many expectations, strategic symmetry has not yet resulted from the loss of America's absolute advantage. Instead, the United States appears to have enjoyed, up to the present, a sufficient advantage to deter a range of Soviet aggressions short of an all-out attack upon this country, as well as Soviet attacks on the United States itself.

The contribution of our strategic nuclear forces to deterring less than all-out Soviet attacks upon the United States rests upon the threat of a U. S.-initiated strategic attack upon the Soviet Union, and not directly upon the threat of U. S. second-strike retaliation. This is not to deny the primacy of our second-strike retaliatory power, without which the threat of a U. S.-initiated attack would be an invitation to Soviet surprise attack or preemption. Nevertheless, deterrence of major Soviet aggression short of attacks on the United States involves the Soviet estimate of the likelihood that American political leaders will initiate thermonuclear war. Soviet fear of American initiation will diminish as the prospective damage to the United States or its Allies grows, and as the likelihood of a decisive American military victory diminishes. The ability to threaten the destruction of the Soviet Union, if it also means the destruction of the United States, is an effective threat only against Soviet acts that leave the United States with nothing to lose. To deter lesser Russian aggressions, a direct threat to initiate general nuclear war is rarely necessary. If the Russians are opposed at lower levels of conflict, they face the choice of increasing the level of conflict or backing down. And U. S. strategic forces that pose a credible threat that the United States may initiate a counterforce strike make escalation dangerous for the Russians.

The ability to reduce Soviet damage potential. it is widely supposed. will inevitably decline and wither away as Soviet strategic offensive capabilities grow and become better protected.* The heralded strategic symmetry. so far unaccountably delayed, is still widely believed to be only a matter of time. This prediction is often based on simple notions of "reasonable" Soviet behavior "in the long run." However. simple models of Soviet behavior have poor records as predictors: and short-run disturbances often prevent long-run trends from being realized.

The following analysis is concerned with U.S. damage-limiting ability at about 1970. assuming various programs for strengthening our strategic offensive and defensive forces (including civil defense). When we make predictions on this subject. and especially when we decide whether to make the effort to preserve our ability to reduce Soviet damage potential. our uncertainty about Soviet behavior is critical. It is insufficient to say that. in the Soviets' shoes. we would try to build up a secure retaliatory force of hard ICBMs or submarine-launched missiles (SLMs). The relevant question is. Will they? Beyond that. if they do. how fast will they accumulate such forces? Where will they level off their buildup? How hard will their hard missiles be? And so on.

The more specific we make our predictions. the less likely they are to be correct in all details. To show the implications of uncertainty about the Soviets. three Soviet postures will be considered. Two are reasonably direct extrapolations of past Soviet behavior. but. of these. the first. Soviet posture I. strains U.S. damage-limiting ability far less than Soviet posture II. Soviet posture III is an illustration of what the Soviets might do to achieve a second-strike retaliatory force if they were limited only by budget levels and foreseeable technological constraints.

Before the Soviet postures are described and the results of U. S. strikes against them analyzed. the remainder of the Introduction will discuss the form of the analysis and explain the report's concentration on U. S. first-strike capabilities. Section II then presents the alternative Soviet postures and discusses their relative plausibility. Sections III and IV. respectively. show the performance of

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*H. Kissinger. "Strains on the Alliance." Foreign Affairs. January 1963. pp. 261-285.

postures (including some with improved antimissile defenses) against Soviet postures I and II. Section IV also discusses improvements to U. S. offensive forces. and shows their effects against Soviet posture II. Section V comments on the significance of Soviet posture III. and Section VI presents the conclusions.

THE MEASUREMENT OF FIRST-STRIKE CAPABILITY

A U. S. -initiated counterforce strike excludes preventive war for the purposes of this discussion. That subject will not be discussed since it is contrary to U. S. policy as we understand it. Instead we assume that a U. S. -initiated strike would only be a last resort. the result of a preceding crisis or limited war that had got out of control. Therefore. the U. S. -initiated attacks to be considered all occur with the military forces of both sides on as high a state of alert as they can maintain. In addition. a U. S. -initiated attack possesses two characteristics that differentiate it from Soviet-initiated attacks. First. if the United States initiates. the attack is likely to occur with undamaged U. S. forces. Second. such attacks offer better prospects for catching Soviet forces before they are launched.

In what follows it will be necessary to refer to various kinds of military capability. Damage-limiting capability. as we shall use the term. is not synonymous with counterforce capability. It also includes active defense. passive civil defense. and wartime coercion. Counterforce and defense both tend to reduce the offensive potential of enemy weapons. They work on enemy capability. Coercion. on the other hand. operates on the opponent's will to use the offensive potential he possesses. In peacetime. coercion is the basis for deterrence of attack. In wartime. the objective of coercion is to induce an enemy to act in conformity with our desires while he still has power to resist us. Coercion may aim at deterring enemy initiation of countercity attacks by threatening to retaliate against such attacks while offering to withhold civil damage so long as the enemy does. It may also attempt to induce suspension of military operations on terms favorable to us. To anticipate. a principal conclusion of this analysis is that the best hope for maintenance of damage-limiting capabilities lies in combinations of the various classes of measures mentioned.

The purpose of a U. S. -initiated counterforce strike would be to shift the military balance in our favor. To evaluate such a strike we will use a three-part measure of the outcome. First, coercive power will be measured in terms of the <u>residual damage potential</u> at various times during the course of the strike: the additional civil damage that each side could inflict at any time with its surviving forces. The factors that mediate between damage potential and the effectiveness of coercion are well known and need no elaboration here. At the very least coercion depends on the perception of the threatened damage by the subject, his valuation of the damage, and the strength of his belief that his opponent will execute the threat. The damage potentials will generally be measured in terms of civil mortalities, which is a highly oversimplified index of civil damage, and an even less satisfactory measure of the coercive abilities of military forces. Its use represents a compromise between realism and the requirements of analytic feasibility. Appendix F also contains some tentative observations on economic damage and the implications for recuperative capability.

A large-scale nuclear exchange will inflict some civil damage even if it consists of counterforce strikes in which both sides aim at minimizing collateral civil damage. Moreover, it is necessary to consider the outcomes of cases in (b)(1) [redacted] to each side is the second element of our measure of the outcomes of nuclear exchanges. The realized damage to the United States in a U. S.-initiated strike reflects the cost of achieving a more favorable strategic balance (as measured by the damage potential). Reducing Soviet damage potential against the United States at the cost of a very high level of realized damage to this country would, of course, constitute an unsatisfactory outcome. Realized damage inflicted on the Soviet Union can also reduce the effectiveness of U. S. coercive threats as a deterrent to Soviet punitive strikes. If U. S. counterforce attacks inflict very high levels of collateral damage, the Soviets may doubt that we are fighting a controlled war at all, or they may react emotionally and seek revenge for their suffering. In either case, high realized damage may lead them to abandon restraint when it is in their interest (as well as our own) to observe it.

The coercive power of a military force is not restricted to its ability to threaten civil damage. In the event of general war, especially a controlled one, military operations would probably occur in many local theaters during and after the strategic exchange. To terminate a general war on favorable terms, it would be necessary to cope with Communist local operations as well as to defeat their strategic forces. Strategic nuclear forces remaining after the initial phase might have a substantial military effect on the outcome of such operations. Anticipation of these effects might give the stronger side additional leverage in its coercion of the weaker. To suggest the extent to which strategic forces might affect local operations or continue counterforce operation, the residual strategic forces on both sides at various stages of the war will be displayed as a third measure.

With this three-part measure, the results of nuclear strikes initiated by the United States under a variety of circumstances will be calculated. The results are intended to clarify some important aspects of the choice of strategic force structure and to illustrate some possible characteristics of the future balance of strategic power. We believe the cases chosen are plausible and that they bear on critical issues, but we recognize that they are not exhaustive. They are not, therefore, a sufficient basis for policy choices, but rather an aid.

Among the hardest things to incorporate in calculations are enemy doctrine and response. Looking forward to 1970, Soviet strategic posture is unknown to us, if for no other reason than because no Soviet leader knows in detail what the Soviet posture will be. Soviet leaders cannot make decisions now that would fully determine that posture. Our uncertainty is greatest about the relatively changeable elements of 1970 Soviet posture, such as doctrine, plans, and operating capabilities. Though these cannot be known in 1963, responsible American decisionmakers may have information of this sort now about the current Soviet posture (although little of this information is available to the authors). Similarly, decisions regarding U.S. action in 1970 may be based on considerably more information on the 1970 Soviet posture than anyone has at the present. To analyze the 1970 Soviet posture and plan our own force structure, we have to make bracketing assumptions where uncertainty is important. This will be especially true for Soviet doctrine and operational response; specifically, whether the Soviets manage to launch their forces prior to the impact of our attack and how they target their operational and surviving forces.

There is little evidence in the material available to us on Soviet military thinking that the Soviets are interested in developing a doctrine for controlled or large-scale limited war with the United States.* However, the evidence is far from sufficient to warrant the assumption that the Soviet response to any large-scale hostilities would inevitably culminate in all-out attacks on concentrations of population and industry. Soviet doctrine does not include exact counterparts of U.S. strategic concepts. Although there appears to be a "deterrence by terror" school among Soviet strategists, it does not appear to be dominant. Prevailing Soviet doctrine seems to assign greater weight to the ability to fight wars successfully -- though not necessarily on the style of U.S. controlled response. Whatever the governing doctrine, evidence available to the authors says little about how it is translated into the specific details of Soviet war plans. Moreover, if actual war plans can severely circumscribe the freedom of choice of political leaders, they cannot absolutely determine the choice. So long as control remains with Khrushchev, he may choose to surrender (or what may be equivalent to it, to temporize), especially if the military alternatives involve great injury to Soviet interests. But if Soviet leaders are bluffing, consciously or otherwise, they will, of course, try to conceal it from the United States. The bluff could even extend to their actual war plan, so long as the execution of the plan was contingent on political decision.

Finally, even detailed knowledge of Soviet war plans and intimate acquaintance with the intentions and likely behavior of Soviet leaders tell us little about likely Soviet response in 1970. Much of our information relates to discussions that took place before controlled response was firmly established U.S. policy, or at least before the official Soviet strategic doctrine had had a chance to assimilate it. And we know from our own experience that doctrine can change rapidly, certainly within a decade. We also know that controlled response will offer Soviet leadership strong incentives to maintain their own flexibility of response in fact, whatever declaratory policy they adopt. The weaker side can rarely afford the luxury of a declaratory policy consistent with actual policy.

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*See H. Dinerstein and T. Wolfe, The Basis for Understanding the Soviet Military Problem in the Sixties (U), The RAND Corporation, RM-3631-PR, July 1963 (Secret).

THE RELEVANCE OF PERFORMANCE IN U. S. -INITIATED STRIKES

The ability to retaliate and limit damage to the United States in the event of an enemy surprise attack is an accepted criterion for our strategic force structure. The ability to prevent an enemy from retaliating strongly in a U. S.-initiated attack is less widely accepted. To be willing to consider U. S. initiation of a nuclear exchange is often called aggressive. or suicidal. or both. Lengthy argument is possible on this subject. but we shall confine ourselves to offering three reasons for analyzing our performance in this contingency. They are consistent with authoritative statements of policy. both classified and public. available to the authors.

First. the United States has committed itself to defend its Allies. particularly the NATO Allies. against aggression with whatever elements of U. S. military strength are required. In the event of a large-scale Soviet attack on our NATO Allies. or if we were convinced one was imminent. a counterforce strike against at least the Soviet strategic nuclear capability might be required. Such Soviet aggression may appear unlikely. but likelihood in this matter is highly dependent on the consequences of the Soviet act. A U. S. posture that makes an effective U. S. response appear relatively likely to the Soviets justifies the low probability estimate we are inclined to assign to a large-scale Soviet attack on Western Europe.

Crises or local conflicts are more likely than an abrupt. major Soviet aggression. The possibility that low-level conflicts may escalate to general war appears to be recognized by the Administration as constituting the greatest danger of general war. Concern for the threat of nuclear war as the ultimate consequence of conflicts originating over Cuba. Berlin. or perhaps even Laos. implies that differences in central war posture may exert a real if subtle and indirect influence on the attitudes of each side toward meeting its opponent's moves and initiating moves of its own. A U. S. first-strike damage-limiting capability may affect the Soviets even if both U. S. moral compunction and the risk of damage make it evident that the United States would never implement a policy of massive retaliation to low-level Soviet aggression. Even then. the Soviet Union would face the prospect of defeat at low levels of conflict or escalation to high levels where the U. S. attack might appear more likely. By its effects on anticipations. the U. S.

first-strike strategic capability may simultaneously strengthen the resolution of American and Allied decisionmakers at low levels of conflict and deter initiatives on the part of the Soviets. Its effects on the escalation process are the second reason for considering U. S. first-strike capability.

Third, and perhaps the most compelling reason for considering the performance of alternative U. S. forces under the assumption of U. S. initiation, is that among the various ways in which large-scale nuclear wars might begin, given the expected postures on both sides for 1970, one must assign relatively high probability to U. S. initiation. Although by 1970 the ability of the United States to limit damage may become questionable, the projected Soviet posture appears to be wholly unsatisfactory as a basis from which they might initiate an attack. A detailed explanation of this assertion must be deferred until after the discussion of Soviet posture in the following section. Its basis is the inability of the Soviets, even with complete strategic surprise, to destroy enough of the U. S. nuclear capability to reduce U. S. damage potential below disastrously high levels. At the same time, the Soviet counterforce attack would leave the Soviet Union with small remaining forces.

This situation would leave the Soviet Union with little inclination to initiate a nuclear exchange, unless Soviet leaders became almost certain of an impending U. S. strike which could not be turned aside by Soviet concessions. A consequence of U. S. success in achieving second-strike retaliatory capability is that the most likely kind of large nuclear war, if it occurs at all, is one initiated by the United States.

Therefore, the preoccupation of this report with our first-strike capability should not be taken as an indication of indifference to our retaliatory capability.* The general agreement on the importance of secure forces, and the failure of the Soviet buildup to challenge our retaliatory ability, suggest that the critical planning issues lie elsewhere. Whether to maintain the ability to reduce Soviet damage potential, on the other hand, seems to us to be an issue whose resolution will be basic to all our national and alliance security policies, and about which there

*The broader study, which includes the analysis of this report as one part, considers the problems of achieving a secure second-strike capability against more threatening Soviet postures.

exists no clear consensus. It has been argued that the retention of a first-strike threat with deterrent value will be impossible or too expensive, if possible, and that there are preferable alternatives. In what follows, we assess the extent of the capabilities available under various assumptions about the Soviet posture, and try to give a very rough notion of the cost of improving U.S. capabilities beyond those definitely programmed for U.S. forces. The results are relevant to the choice of posture but not sufficient for it. To decide how far to pursue U.S. first-strike capability requires consideration of other claims on the defense budget and other ways of deterring Soviet aggression, both of which are beyond the scope of this report.

II. THREE SOVIET POSTURES

THE PURPOSE of this report is not to contribute to the prediction of Soviet posture, but rather to deal with the implications of different U.S. posture choices.* To do this and give appropriate expression to the uncertainties about Soviet posture, we have chosen Soviet postures that vary significantly in their susceptibility to U.S. counterforce operations, but are consistent with what we know of Soviet technological and resource constraints. Soviet postures I and II are relatively modest departures from AFNIN estimates as of the end of 1962. Soviet posture I was chosen so that programmed U.S. counterforce capabilities (though not programmed U.S. damage-limiting capability) are adequate against this posture. Soviet posture II provides a counterforce task beyond the capabilities of currently programmed U.S. offensive forces, though not beyond the capabilities of improved forces. Soviet posture III represents a greater departure from AFNIN estimates and is sufficiently invulnerable to currently known counterforce tactics to make counterforce a relatively unprofitable component of U.S. damage-limiting capability, and to bring the United States and the Soviet Union much closer to a situation of strategic symmetry than exists at present.

In this section we describe the three postures, their phasing, and budget implications, then we comment on their relative plausibility as predictions of the Soviet 1970 posture. Finally, we very briefly consider the implications of these postures for the threat of a Soviet-initiated nuclear attack on the United States.

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*The authors have benefited, however, from contact with the participants in RAND's Project SOVOY, which is aimed at improving capabilities to predict Soviet posture by studying the development of Soviet military forces in the recent past. In particular, we have drawn on the work of E. D. Brunner, Soviet Air Armaments and Their Costs, 1946-1961 (U), The RAND Corporation, RM-3508-PR, May 1963 (Secret-Restricted Data).

THE NATURE OF THE THREE SOVIET POSTURES*

Postures I and II, as summarized in Table 1, are relatively modest departures from AFNIN estimates as of the end of 1962. These two possibilities for 1970 Soviet strategic forces embody the following major considerations:

1. They evolve from the 1964 Soviet strategic force as currently characterized by the intelligence community.
2. The rate of spending for strategic offense, defense, and civil defense remains essentially constant over the period 1964-1970. The annual level of expenditure is roughly $11 billion, reckoned in U.S. dollars.
3. Soviet force planning retains much of its past character, including important emphasis on antibomber defense. No dramatic deactivation of current weapon systems occurs: rather, changes in strategic force composition come at an unhurried pace.
4. In developing posture I, Soviet planners tend to be sluggish in the procurement and deployment of new ICBM systems: instead they favor upgrading the performance of the SS-7 system as technological advances permit.
5. In developing posture II, Soviet planners borrow some of the U.S. enthusiasm for Minuteman-like ICBMs and consequently shift their focus to the SS-9 system.

By contrast, posture III has a design embodying the choices that U.S. system analysts believe the Soviets "ought" to make for a secure retaliation capability. In posture III, Soviet decisionmaking is largely relieved of inflexibilities in strategic doctrine, bureaucratic inertias, concern for sunk investment in currently operational systems, and other such constraints that may well dominate real world Soviet decisions on strategic force composition. The level of spending for posture III (on strategic offense, air and missile defense, and civil defense) is permitted to grow at a 5 per cent annual rate, the pace at which the Soviet GNP is now believed to be increasing.

*Appendix A discusses the postures at greater length.

Table 1

SUMMARY OF THREE 1970 SOVIET POSTURES

Forces	I	II	III
STRATEGIC OFFENSIVE FORCES			
Missiles			
SS-7 soft	220	220	0
SS-7 hard[a]	420	180	0
SS-8 soft	40	40	0
Heavy-payload (2nd generation) ICBM barge-based or in super-hard silos	0	0	80
SS-9 hard	0	480	0
SS-9 super-hard	0	0	400
SS-9 barge-based	0	0	400
Sub-launched	419	419	494
SS-5	150	150	220
SS-4	300	300	300
Bombers			
BADGER	200	200	180
BLINDER	225	225	0
Follow-on heavy	120	120	0
Multiple purpose, long-endurance aircraft	0	0	90
DEFENSIVE FORCES			
Antibomber Defenses			
Manned interceptors	1700	1700	0
Multiple purpose, long-endurance aircraft carrying Eagle missiles	0	0	225
SA-2 batteries	1100	1100	990
SA-3 batteries	500	500	500
Antimissile Defenses			
Nike-X-type batteries	15	15	35
Civil Defenses			
Special fallout shelter spaces	20 mil.	20 mil.	45 mil.
Improvised shelter spaces	50 mil.	50 mil.	60 mil.

Note:

[a]Does not include one additional reload missile per launcher.

Taken together, this sample of three by no means spans the credible alternatives for future Soviet strategic posture. Nevertheless, the three are sufficiently disparate to imply profound differences in the potential of the United States to limit general war damage to itself, depending on its own defense preparations.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[redacted]

Other major systems for both postures I and II resemble intelligence projections with exceptions as follows:

1. The buildup of advanced nuclear submarines, resembling a scaled down Polaris, reflects a slower program that deploys 18 submarines (carrying 108 missiles) by 1970. This is, in part, due to fiscal constraints imposed by the constant budget level. Also, in part, it might be a consequence of a Soviet planning view that the United States is readily deterred from initiating general war by the prospect of more than a few million casualties. (The buildup of the more modest H-class and E-class nuclear submarines to forces of 23 and 24 boats, respectively, does conform to the present expectations of the intelligence community.)
2. The antimissile defense system has the characteristics of a Nike-X system, that is, it uses Sprint-type interceptor missiles, delayed commitment, and hardened phased-array radars, rather than the low-performance Nike Zeus-like system of the current intelligence image based on existing evidence. This does imply a significant redirection of the Soviet development program in the near future, similar to that now occurring in the United States.

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*For a discussion of missile hardness in relation to the SS-9 (but also with more general relevance), see Section IV below.

3. There is a moderate expansion of civil defense preparations, to afford some type of prepared sheltering for an additional one-third of the population. Approximately $4 billion is spent in the 1964-1970 period. Of this amount, more than one-half is used to construct 20 million high-quality, underground fallout shelter spaces in the largest cities (particularly the six or so largest cities at which the 15 antimissile batteries are emplaced). The remaining 50 million spaces are created by improving the potential of existing buildings for fallout protection.

Posture III is distinct from the other two postures in its composition, in spite of a common 1964 starting state. The Soviet planners ruthlessly eliminate currently operational systems in favor of advanced weapons that particularly emphasize survivability. The 800 SS-9s are equally split between two forms of counterforce resistant basing techniques, submersible barges and very hard silos. The first generation heavy payload ICBM, the soft, slow-reacting SS-8, is displaced by an advanced system eliminating the operational disabilities of the SS-8. A multiple-purpose, long-endurance (MPLE) aircraft has been introduced in place of the unimaginative follow-on heavy type that appeared in postures I and II; further, the MPLE bomber has been provided with several sophisticated payload items including a standoff missile resembling the U.S. CLAM design, an AAM like the U.S. Eagle design, and a recce-strike radar with terminal missiles. This type of aircraft with Eagle-like missiles is also introduced as the antibomber area defense system in place of the traditional manned interceptors. The larger budgets of posture III permit a more generous deployment of antimissile defense -- 35 batteries at (say) 12-15 cities. Finally, civil defense shelter provisions have been purchased for an additional one-half of the population.

THE PLAUSIBILITY OF THE THREE SOVIET POSTURES*

There are two principal points to make regarding the plausibility of the three Soviet postures. Postures I and II probably cover the most important and pertinent range of 1970 postures against which to test the continued feasibility of the

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*This section is an adaptation of a talk by Andrew Marshall. It was presented to the RAND Air Force Advisory Group, April 12, 1963.

counterforce mission. Nonetheless, the results of the calculations we present here, if taken as a prediction of the future, may in fact turn out to be too pessimistic from the U.S. point of view. Although postures I and II are a good and prudent basis for planning our own future posture, there are some reasons for believing that the 1970 Soviet posture may offer better opportunities for counterforce operations than our current calculations suggest. The second point is that posture III is rather implausible as a 1970 Soviet posture.

The reason for suspecting that counterforce may be easier than postures I and II suggest is not that the Soviets may procure fewer of particular systems. Qualitative aspects of Soviet forces are much more important than force size in determining how easy or difficult counterforce operations may be. Qualitative aspects comprise the sort of basing systems they choose, their command and control systems, and a variety of aspects of the mix of their forces. We do not now have, and may never have, good ways of forecasting Soviet postures 5 to 10 years in the future. Therefore, the postures we project and use in our calculations often fail to reproduce many of the characteristics of past Soviet postures, even when we construct several alternative projections against which to test U.S. forces.

A current RAND study (Project SOVOY) of the evolution of Soviet military posture from 1946 to the present suggests that the evolution of the Soviet military posture is slow, complicated, and uneven. A variety of deficiencies existed in the past and often for very long periods of time. There are a number of unanswered questions about the reasons why Soviet posture has evolved as it has.

Thus, although postures I and II have been developed subject to constraints by some of the factors we understand best -- for example by over-all budgets, the expenditure split between offense and defense, the rate at which new systems can be phased in and old systems phased out, and the rate of technological innovations -- nonetheless these postures do not contain the kinds of out and out mistakes that have been characteristic of past Soviet postures. For example, during the fifties, the Soviets spent 6 or 7 times more on antiaircraft artillery than they did on the whole of the BISON and BEAR programs. Air defense is one of their most important missions; nevertheless, as late as 1961, between one-quarter and one-fifth of their total air defense expenditures was being spent on antiaircraft artillery. All known technical judgments indicate that these weapons are very nearly useless against modern air attack. Concurrently, the Soviets were very slow in attaining an all-weather defense capability. In the early fifties this was one of the most glaring holes in their air defense posture. Another instance of Soviet behavior unlike that assumed in our projections is their very slow, halting, irregular development in achieving a significant intercontinental offensive capability.

In contrast to these deficiencies in past Soviet postures, in postures I and II Nike-X has been substituted for the currently estimated Soviet ABM system. The Soviet system appears to have characteristics that would make American decision-makers hesitate to buy it. In fact, it would not be unreasonable, given past performance, to expect that the Soviets might deploy even relatively deficient ABM systems in fairly large numbers.

There are also some operational aspects of future Soviet postures so uncertain that the calculations require bracketing assumptions. This is especially true of assumptions about likely Soviet command and control systems and Soviet reactions under attack. It is conceivable that the first U.S. missile strike may so derange Soviet command and control capabilities that the remainder of the Soviet force will be immobilized until the follow-up bomber attack arrives to destroy it. Also, although it is assumed that the U.S. strike occurs in a time of crisis with Soviet forces in a high state of readiness, there is a question as to whether the Soviet reaction capability may not deteriorate during a long crisis, one that lasted, say, several weeks. There might then be better opportunity for counterforce operation than indicated by our calculations. These aspects of Soviet performance are likely to be important determinants of the effectiveness of U.S. counterforce operations. Past Soviet performance suggests that they may not do as well in some of these areas as conservative U.S. predictions suggest. They have procured missile systems with reaction times (from peacetime states of readiness) measured in hours. They have shown a marked reluctance in the past to marry warheads and carriers, both missiles and aircraft: and this has tended to make their reaction sluggish.

There is reason to believe that the Soviets will do better in the future than they have in the past in the planning and programming of their forces. They seem to be more interested in the planning of their intercontinental offensive capabilities than they were before 1960. The available material on Soviet discussions of strategic questions suggest this.* But in this connection, the examples of past poor performance with regard to the air defense mission are especially important, since the Soviets have been extremely interested in this mission, and quite willing to spend large amounts of money for it. Intense Soviet interest in a particular mission is not necessarily a guarantee of high performance. RAND's study of the past evolution of Soviet military posture also shows that there have been very large discrepancies between what they said and what they did. Their difficulties are probably built very deeply into the functioning of the Soviet military bureaucracy. Past poor performance is not just a matter of past intellectual or doctrinal errors.

On balance, it seems that counterforce may be easier in 1970 than calculations today might show it to be. However, in planning our forces, it is difficult to foresee precisely what deficiencies future Soviet postures will shown. It is important, therefore, to make provisions to recognize Soviet mistakes as early as possible; and U.S. planning should include the flexibility to take advantage of mistakes when they do show up. Early recognition may depend on a reorientation of U.S. Intelligence efforts and estimates toward the qualitative aspects of Soviet forces instead of the size of their forces and the number of their weapons. However, there are limits on how far into the future we can see: and the planning of U.S. forces will always have to be done in the face of major uncertainties. A better understanding of how the Soviet military bureaucracy really works appears particularly important to better forecasting of future Soviet postures. An understanding of Soviet bureaucratic style, we believe, could lead to new and different explanations of why the Soviets have done certain things in the past and why they might do certain things in the future. The analysis of past Soviet military decisions and the attempt to forecast future Soviet posture has been marked by a tendency to overrationalize and overintellectualize such decisions. The explanation of past Soviet choices often proceeds in terms appropriate to the actions of an individual with an internally consistent set of interests. But the Soviet military posture undoubtedly evolves from the decisions of a fairly complex bureaucracy.

*H. Dinerstein and T. Wolfe, op. cit.

The actions of a bureaucracy cannot be adequately explained so simply. For example, the decisions made by a committee cannot be analyzed as though they were made by an individual -- one perhaps with a low I. Q. who makes mistakes in logic. What matters in the committee decision is the structure of the committee, the method of voting, and other characteristics of this sort. A committee's decisions cannot be rationalized on the same basis as those of a rational human being. The famous charge of the Light Brigade illustrates the point very well.* The reasons for this shockingly wasteful act had to do primarily with the personal feelings and relations of two of the British officers, a garbled and ambiguous message, and the reluctance of those involved to seek clarification of what was, to the people who received it, very likely a mistaken order. The reason why the charge took place had very little to do with any notions of military strategy, doctrine, and so on. And it is not only in the heat of battle that personal rivalries, poor communications, lack of feedback, and other factors play an important role in deciding what will be done.

Posture III reflects the absence of nonrational constraints on Soviet decision-making to a much greater extent than either of the other postures. It imputes to the Russians a view of the requirements for deterrence that is symmetrical to the views of U.S. defense analysts. In terms of the nature of the objective, the single-mindedness with which it is pursued, and the particular weapon systems chosen to implement it, posture III represents a significant shift from discernible Soviet behavior in the past. It implies a kind of flexibility in programming and a ruthlessness with respect to sunk costs that is quite uncharacteristic of any large organization, Soviet or American. In posture III, the Soviets scrap all of the SS-7s and SS-8s and go on to wholly new systems by 1970. A program of the size and scope of the current SS-7 program has built up great momentum. It is extremely difficult to stop such a program in mid-course, let alone to eliminate operating costs by scrapping the units that have already been built.

Posture III is implausible both as an estimate for a 1970 Soviet force and as a basis for planning our own 1970 force; nonetheless it serves a very useful purpose. It shows directions that the Soviets might take, perhaps at a later date, that

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*See Cecil Woodham-Smith, The Reason Why, New York, McGraw-Hill, 1953.

might make counterforce very difficult. Although it is not a reasonable basis for procurement decisions, it may be useful in guiding our R&D decisions. Consideration of the deficiencies of counterforce against this posture suggest problem areas to be explored if the United States is to retain its offensive effectiveness even against well designed retaliatory forces.

DEFICIENCIES IN SOVIET FIRST-STRIKE CAPABILITIES

None of the three Soviet postures is effective enough to make a Soviet-initiated counterforce strike an attractive proposition against the programmed U.S. forces. The programmed U.S. strategic offensive forces are shown in Table 2 in the column marked OSD. This column summarizes a projection to 1970 of the officially programmed Package I forces as of April 1963. Also shown in Table 2, in the column marked USAF Proposed, is the Air Force submission, which differs (for the present purpose) only with respect to the size of the Minuteman force. The USAF proposed force includes 1,000 additional Improved Minutemen. If the Soviets were to contemplate attacking the OSD force with any of the forces shown in Table 1, they would find themselves with between 1,400 and 1,600 usable missiles, depending on the posture.* They would also have a small force of intercontinental bombers.** They would face a target system consisting of approximately 1,500 hard missile silos, between 50 and 150 high priority air field targets, submarine ports, and assorted command and control targets if they were to restrict themselves to a purely counterforce strike against U.S. strategic offensive and defensive forces. This attack would of course leave substantial numbers of Polaris submarines at sea. It is quite clear that such an attack, using

*Including the entire force of SLMs and one reload missile for each hard SS-7 launcher.

**In Section IV, it is suggested that relatively small forces of bombers with sophisticated payloads may provide significant counterforce capability. There is no evidence of Soviet systems like those discussed below, but they could affect the results substantially, and therefore should be a prime concern of our technological intelligence activities. If the Soviets develop an effective capability against hard targets using penetrating aircraft it may be necessary for the United States to construct an area air defense able to survive at least through the initial phase of the war, or to review the mix of hardened and mobile retaliatory forces.

the entire Soviet strategic force, could not destroy a large fraction of even the U.S. hard missile forces, given currently estimated yield and CEPs. This is also true for yields and CEPs that seem likely for 1970. The Soviet counterforce attack could have no reasonable anticipation of leaving the Soviet Union relatively stronger than before the strike. In fact, an attack of the kind described would leave the Soviet Union with very small strategic offensive forces and the United States with substantial forces. Such a result could be chosen by the Russians only in desperation, for example, if they had clear evidence of an impending U.S. strike.

Table 2

PROGRAMMED U.S. STRATEGIC OFFENSIVE FORCES

Force	OSD Program (number)	USAF Proposed (number)
AIRCRAFT		
B-52	585	585
GAM 77 (ASM)	408	408
B-58	66	66
KC-135	615	615
MISSILES		
Atlas E, F, Titan I	153	153
Titan II	54	54
Minuteman A B	800	800
Minuteman C	500	1500
Polaris (missiles on station)	500	500

This conclusion must be qualified by the possibility that the Soviets will either discover or unwittingly stumble upon a critical U.S. vulnerability hitherto unknown to the United States. It is extremely unlikely that the Soviets would embark on a deliberate strike against the United States in the hope of finding some such vulnerability. Moreover, most of the critical vulnerabilities noticed in the past would tend to paralyze the force for a limited period of time and delay its response. For example, U.S. preparations have attempted to guard against threats due to the vulnerability of command and control nodes, the destruction of authority competent to give the execute order, and, at an earlier date, the destruction of nuclear storage facilities. This can be critical when there is some prospect for a follow-on attack sufficient to destroy the individual vehicles pinned down by, say, destruction of the command and control net preventing dissemination of the execute order. It is precisely this follow-on attack that is missing from the Soviet posture shown in Table 1. As a result the Soviets could not hope to put themselves beyond the reach of very substantial U.S. retaliation if they initiated a counterforce attack.* They might, however, find some incentive for initiation if they had some prospect of destroying a substantial fraction of the U.S. bomber force by a small expenditure of Soviet forces. If they were able to do this, they would still be faced with substantial U.S. retaliatory capabilities, but they would be much closer to a situation of parity with the United States with respect to secure residual damage potential. The Soviets will, therefore, have some incentive to try to preempt in the event of an impending U.S. strike if they believe they can catch a substantial part of the U.S. bomber force. For the same reason, it is of great importance for the United States to try to assure the survival of enough bombers to do the counterforce job by providing adequate warning, alert, and dispersal in times of high tension.

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*However unsatisfactory an attack of this kind might be to the Russians, having to improvise launch control for Minuteman in wartime would also be unsatisfactory for the United States. It is therefore important to pursue measures to provide backup capability in the form of an airborne launch control center for the entire Minuteman force.

III. SOVIET POSTURE I: DEFICIENCIES IN U.S. DEFENSE

OF THE THREE Soviet postures we consider, Soviet posture I imposes the least severe requirements on U.S. damage-limiting capability. To begin, therefore, let us consider the performance of the OSD programmed force against this posture. As a basis for the calculations of strike outcomes to be presented, we display some of the alternative allocations of the U.S. force in a U.S.-initiated attack. The outcomes of a representative U.S. strike are presented, then we discuss some of the deficiencies revealed -- in particular those relating to defense -- and reexamine the outcomes under the assumption of improved defenses.

THE ALLOCATION OF U.S. MISSILE FORCES AGAINST SOVIET POSTURE I

To calculate the results of a U.S. strike against the Soviet Union it is first necessary to allocate U.S. forces to Soviet targets. This allocation may be considered an outline strike plan that suppresses almost all the detail of an actual plan, and, for the moment, also abstracts from questions of timing, warning to the Soviets, and Soviet response. These are discussed later; but for the present the allocation will be made as if Soviet forces are immobile until the arrival of the various elements of the U.S. strike.

We begin with the Soviet hard missiles, which pose the most difficult target class among fixed base systems. Figure 1 shows the number of Soviet hard missiles (b)(1) [redacted] surviving attacks by U.S. missiles.* The attacks employ forces varying from zero to the entire alert missile force in the OSD posture, approximately [redacted] missiles. The curve

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*The details of the results are presented in Appendix B. For these calculations, the [redacted] This assumption is discussed in Section IV. Figures 1, 2, and 3 exclude reload missiles.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[redacted]

typically flattens out as the U.S. force size increases. for two reasons. First the missiles in the U.S. force are not homogeneous. but vary from Titan II. which has a relatively good yield-CEP combination for attacking moderately hard targets, through Improved Minuteman. Atlas and Titan I, Polaris. and finally to the Wing II-V Minuteman. The single shot kill probabilities are shown in Appendix B. The solid curve of Fig. 1 is derived by assuming that the "first" missiles allocated to Soviet hard missiles are the best missiles and so on. so that as the total force applied increases, missiles of lower and lower effectiveness are used. A second reason for the flattening of the curve is that the "later" missiles are shot at some targets that have been killed by the "earlier" ones. The missiles are fired without information on which targets have survived attacks by the earlier missiles (as in a volley). For both of these reasons the second 1,000 missiles allocated to Soviet hard missile targets destroy very few additional Soviet missiles.

Allocating the entire U.S. missile force to attacks on Soviet missiles is a poor plan because the payoff becomes very low, and, more to the point, there are other jobs to be done by U.S. missiles. Soft Soviet missiles must be attacked as well as hard. The soft SS-7s, the soft (and, by our assumption, high yield) SS-8, and the soft, movable (but not continuously or frequently moving) SS-4 are also components of the Soviet strategic threat. The dotted curve of Fig. 1 shows that the number of soft Soviet missiles surviving increases as the allocation of U.S. missiles to Soviet hard missiles increases because, with a fixed total, the number of U.S. missiles left to attack the soft missiles decreases. Adding to give the total surviving missiles, a "U" shaped curve, such as the dashed curve of Fig. 1, is obtained. If we spend our entire missile force attacking Soviet strategic missiles

(b)(1) [redacted]

The counterforce target system extends beyond strategic missiles, of course. Other counterforce jobs for U.S. missiles are attacks on such high time-priority targets as [redacted] if these are to be attacked at all. Figure 1 shows a substantial number of Soviet missiles surviving even after the expenditure of the entire U.S. missile force. This suggests that a bomber follow-on attack will be necessary to perform the counterforce mission thoroughly. To make the bomber attack effective, it is desirable to have attacked Soviet [redacted] prior to the arrival of the bombers. Soviet [redacted] In Fig. 2, some U.S. missiles are withdrawn from attacks against Soviet (b)(1) for the tasks just discussed. Two levels are shown for such attacks differing principally in the number (b)(1) (b)(1) attacked.* When the programmed U.S. missile force must cover the high target system as well as Soviet strategic missiles, more than [redacted] Soviet missiles survive. That is to say, with the programmed missile forces, much of the job of destroying Soviet missiles, especially hard missiles, falls on the bomber follow-on attack.

Larger U.S. missile forces could, of course, do more of the job. Figure 2 also indicates the minimum points of curves corresponding to the three shown for the OSD programmed force if we add (b)(1) Improved Minutemen to the U.S. programmed force as in the USAF proposed force. This increase in the number of relatively good missiles for attacking hard targets improves the U.S. performance. If the entire missile force were spent on attacking Soviet missiles, the number surviving could be reduced to approximately [redacted] of the initial Soviet forces. However, when other tasks are examined as before, the missile attack against the high target system leaves over [redacted] Soviet missiles surviving, a substantial force from the point of view of its damage potential. It therefore appears that even with the larger missile force a bomber follow-on attack is required if Soviet damage potential is to be reduced very far.

BOMBER FOLLOW-ON ATTACKS

The next problem, then, is to consider the allocation of the bomber follow-on attack. By 1970, the long range U.S. bomber force is scheduled to consist primarily of B-52s. The B-47s will have been phased out and the B-58s will be present only in small numbers with a questionable operational capability. There

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*The "high" and "low" columns of Table B-2, Appendix B, show the details of these target systems.

[redacted]

Fig. 2 — Programmed U.S. missile force versus SU hard missiles, soft missiles, and other targets

may also be overseas or carrier-based aircraft capable of bombing strategic targets. Depending upon their characteristics, such aircraft might make a substantial contribution to counterforce effectiveness, especially to the timing of the attack. Quick completion of the counterforce attack after the Soviets have received warning is a very important consideration. However, although its great importance can be granted, placing a measure on the importance of speed is difficult. In particular, the time to target for overseas-based bombers or supersonic bombers and that for intercontinental subsonic bombers is impossible to evaluate without precise information about Soviet response patterns. Such information may or may not be available to U.S. decisionmakers regarding current Soviet posture, but it is clearly unavailable in precise enough form to aid in planning our 1970 posture. We have not, therefore, addressed the question of the proper relationship between intercontinental and theater-based forces for strategic capabilities.* Instead, we attempt to assess our counterforce capabilities using only U.S. or ocean-based forces. The bomber follow-on attacks to be considered, therefore, are B-52 attacks on the Soviet hard missile targets.

The B-52s are assumed to descend to low altitude before encountering Soviet local defenses, avoiding exposure to SAMs en route to the target area. [redacted] To simplify the calculations we have assumed that each hard target is defended by one SA-2 and one SA-3 battery (see Appendix B). Hound Dogs are employed to attack some of the SAMs prior to the arrival of the bombers. Figure 3 shows the results of varying the attacking force after the U.S. missile strikes against the high target system. The results are shown for both the OSD programmed missile force and for the USAF proposed force. In the OSD case, approximately [redacted] (b)(1),(b)(3):42 USC §2168(a) of the Soviet missiles are destroyed by the U.S. missile strike. The number surviving the

*Such an evaluation would also have to take account of use limitations on overseas-based forces. Might there be circumstances in which the United States would wish to be able to pose a first-strike threat whether or not all of its Allies were agreed on a course of action? We assume that overseas based forces attacking strategic targets are "backed up" by intercontinental forces.

[redacted]

Fig. 3—Low altitude bomber attacks versus SU posture 1

[redacted]

bomber strike therefore starts at [redacted] and declines as the B-52 force increases. In the USAF case, the larger force of Improved Minuteman leaves less than [redacted] of the Soviet missiles.

The effects of varying the bomber CEP emerge quite clearly from Fig. 3. A [redacted] CEP is a conservative estimate of the performance achievable by a large proportion of SAC crews under operational conditions of low level attack. A [redacted] CEP represents the performance currently achievable against relatively easy targets or by SAC select crews, but is not to be expected with high confidence for a large part of SAC's crews against a target system including some relatively difficult targets. Bomber accuracy in low level attacks is capable of improvement but this may require additional low altitude training, which might seriously shorten the service life of the B-52s by adding to structural fatigue, and may also require improved equipment (which will be discussed in Section IV). If the number of surviving Soviet missiles is to be reduced below [redacted] of the original force a substantially larger force is needed with the [redacted] CEP than with the [redacted] CEP in both the OSD and USAF cases. It takes more than the entire ground alert force to achieve [redacted] destruction in the USAF case with a [redacted] CEP, and more than [redacted] of the <u>generated</u> force in the OSD case. In the analysis that follows, we assume that 300 B-52s are allocated to attacks on hard missiles in both the OSD and USAF attacks.

RESIDUAL FORCES IN A U.S.-INITIATED ATTACK

Figure 4 shows the residual forces on both sides at three stages in the course of the war: before the U.S. missile strike; after the U.S. missile strike but before the U.S. bomber strike; and after the U.S. bomber strike. It is assumed that the Soviets do not launch any of their strategic forces during the course of the war. This may be interpreted as reflecting either a policy of trying to hold forces in reserve or an inability to launch their forces. This assumption is discussed and varied in the course of the subsequent analysis. However, apart from the plausibility of the assumption, the "nonreacting Soviet" case is included to measure the adequacy of our offensive forces without reference to timing of the strike. Questions of timing need be considered only after we determine that we can destroy unexpended Soviet forces.

[redacted]

Fig. 4 — Residual forces in a U.S.-initiated attack, 1970
(SU posture I, SU non-reacting)

*Includes effect of European based forces

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[redacted]

the consequences of variation from 30 per cent to 75 per cent of the force at sea (the higher proportion is the same as that assumed for the U.S. Polaris system).

(b)(1) [redacted]

With respect to the Soviet bomber force, U.S. missiles have been allocated to all known [redacted] (b)(1)

CIVIL DAMAGE IN A U.S.-INITIATED ATTACK

The next step is to determine the effects of the strike in terms of potential and realized civil damage. Figure 5 shows the underlying relationship assuming that the current OCD shelter program is implemented. (The details of the damage calculation are presented in Appendix E.) The striking feature of Fig. 5 is the steepness of the curves in the left-hand portion. This is simply a reflection of the great destructive power of nuclear weapons, the concentration of U.S. population, and the absence of an antimissile defense. Small fractions of the initial Soviet forces can do great damage to the United States if targeted to do so.* As an illustration, the damage potential of the Soviet SLMs varies between 40 and 60 million mortalities depending on the fraction of the force at sea.

As might be expected from Fig. 5 and from the fact that Soviet submarines at sea are assumed immune from attack, the results of the strike are far from satisfactory from the U.S. point of view. [redacted] (b)(1)

[redacted]

Fig. 5 — Civil damage potential of small SU forces
(OCD shelter program – no antimissile defense)

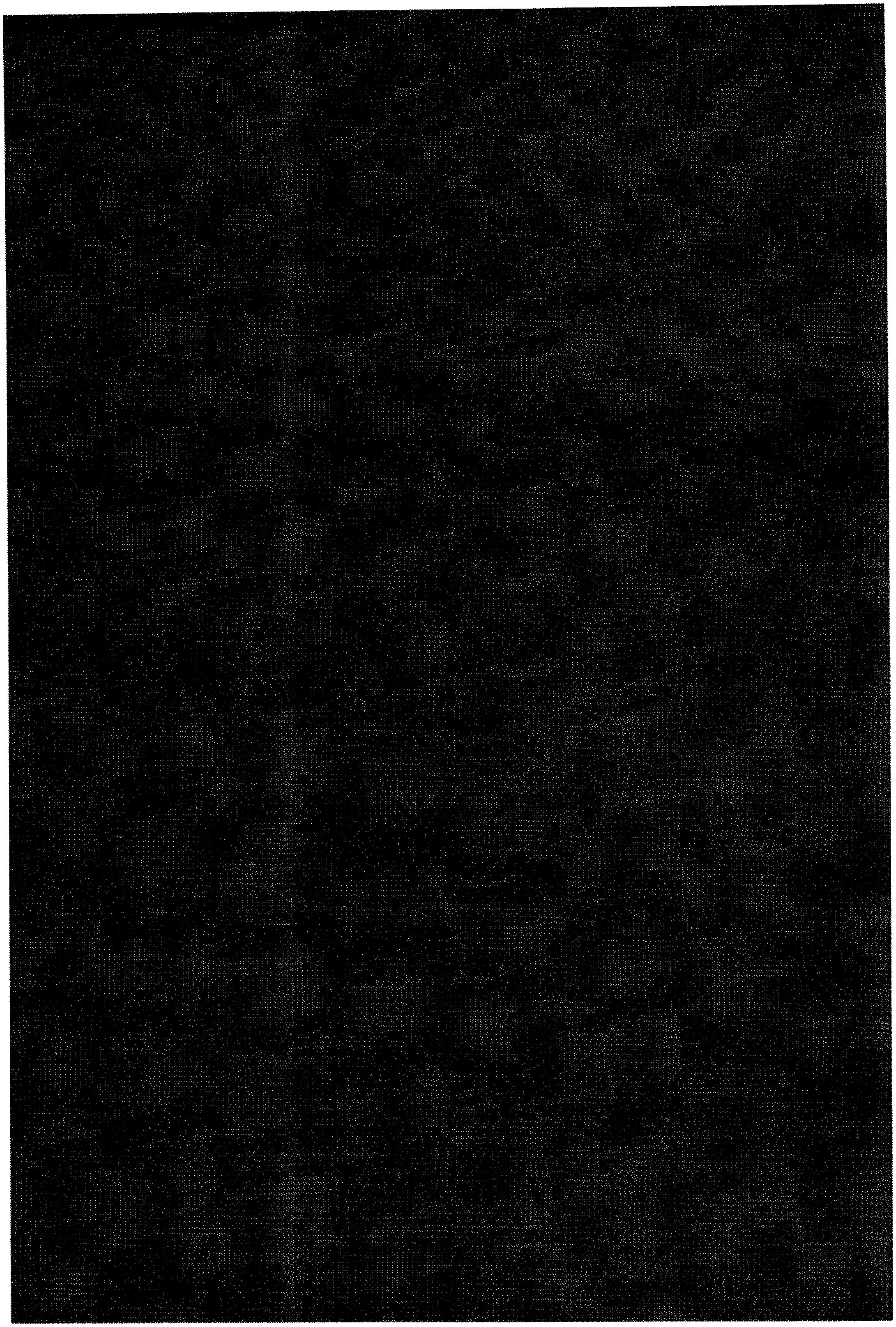

Fig 6 — An unsatisfactory U.S.-initiated strike
(Soviet posture I, 1970)

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

A SOVIET COUNTERFORCE RESPONSE

The results presented so far can be interpreted as showing two extremes of Soviet behavior. They may occur if the Soviets attempt merely to hold forces in reserve (either because they wish to be in a position to threaten the United States or because they have in fact been successfully coerced by the United States). At the other extreme, these results show what would happen if the Soviets were to engage in all-out attacks designed to maximize U.S. and allied mortalities at various stages of the war.

Actual Soviet targeting would very likely fall somewhere between these two extremes. (A hypothetical Soviet strike plan is presented in Appendix C.) Recent discussion of Soviet strategic doctrine suggests that the Soviets would attempt to

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*An "effective" antiballistic missile system is defined here as one capable of discriminating decoys of significantly lighter weight than actual warheads at an altitude high enough to effect an intercept.

strike military targets as soon as possible in the event of a strategic nuclear exchange. Figure 7 shows some results of such a response. The Soviet counterforce attack, however, need not be consistent with the U.S. controlled response doctrine. We have examined a far less discriminating and less restrained attack than that assumed for the United States, one that results in very substantial collateral damage to the United States. The results are also strongly affected by the speed of Soviet response. Figure 7 covers two cases, one in which the Soviets are able to launch their forces prior to the impact of the U.S. missile wave, which we label a Soviet preemptive case; and another in which the Soviets are assumed to launch only after the impact of the U.S. missile wave but prior to the arrival of the U.S. bomber attacks, which we label a Soviet second-strike case.

The preceding discussion of deficiencies in Soviet first-strike capabilities* suggested that the principal Soviet opportunity for counterforce effectiveness would be for attacks on manned aircraft, both the SAC bombers in the U.S. ZI and theater-based forces. If the Soviets [redacted] The assumed Soviet strike plan reflects this view.

Barring a breakdown in U.S. command capabilities, or unforeseen missile vulnerabilities, the [redacted] The attack does not cover all U.S. missile installations; to do so seems unwise for a Soviet planner because the attack would be thinned elsewhere.

As either first or second-strike attacks against U.S. military capabilities [redacted] However, as at Pearl Harbor, these are "one-shot" attacks. *It is difficult to judge the relative capabilities of the United States and the Soviet* Union to adjust and improvise after the attacks.

Either contingency shown in Fig. 7 results in very substantial U.S. collateral damage, less than (b)(1) and about (b)(1), respectively. Moreover, Soviet

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*See Section II, "Deficiencies in Soviet First-Strike Capabilities."

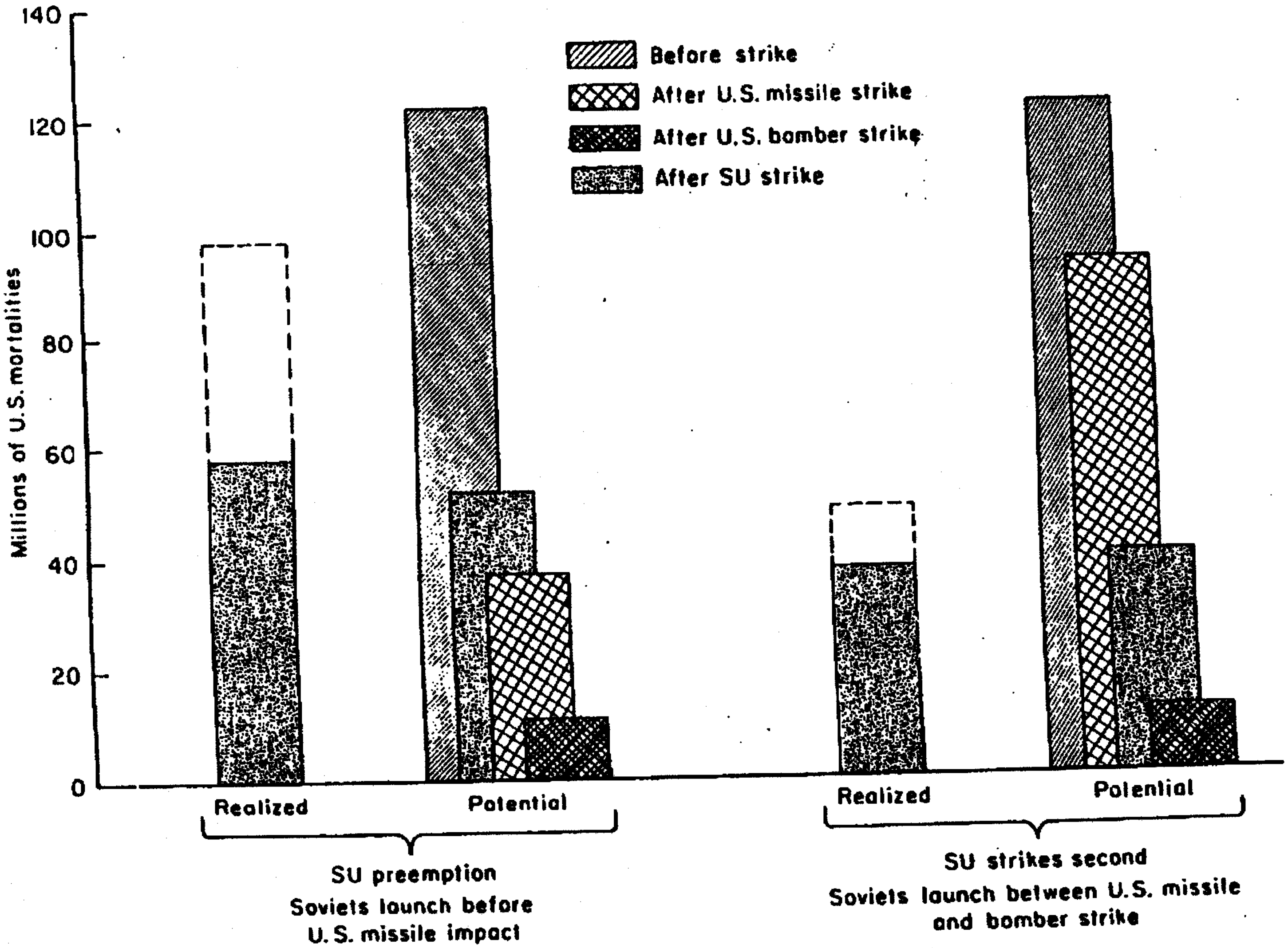

Fig. 7—Soviet counterforce reaction
(U.S. civil damage, SU posture I)

targeting doctrine includes target classes referred to as economic industrial targets and governmental targets. Attacks on these targets are intended to make resistance impossible. If the Soviets should attack targets of this sort, the damage in terms of civil mortalities might be considerably higher, perhaps up to 100 million as indicated by the dashed line in Fig. 7 for the Soviet preemptive case and approximately *50 million for the Soviet second-strike case.* The Soviet residual damage potential is substantially reduced from the nonreacting cases already discussed, but this is cold comfort because of the very great realized damage inflicted by the military response.

LIMITING DAMAGE BY IMPROVED DEFENSE

The inadequacies of the results shown in Figs. 6 and 7 are largely a result [redacted] *Figure 8* compares the Soviet residual damage potential displayed in Fig. 6 with the damage potential [redacted] Such systems are currently being considered and promise significant defense capabilities at moderate levels of cost.* However, Fig. 8 also suggests that, in the absence of defenses against ICBMs, even a *perfect defense* against the SLMs and a highly effective attack [redacted]

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*A forthcoming RAND Memorandum, Area Defense Against Submarine Launched Ballistic Missiles: An Interim Summary Report by I.S. Blumenthal describes several future systems and suggests R&D on sensors for them, and further study of the various systems.

[redacted]

Fig. 8 — The effect of surviving Soviet SLMs
(SU posture I damage potential versus the U.S.)

*30% at sea

For further improvements we are led to terminal defenses against ICBMs. Figure 9 shows the results of two hypothetical defense programs. They both incorporate deployment of a Nike-X system assumed to be effective against ICBMs and SLMs,* the goal of the current antiballistic missile development effort. Program A assumes that the system is deployed at each of the ten largest urban areas in the United States. Program B assumes deployment at the 50 largest urban areas. The population of the protected urban areas is also given specially constructed fallout shelters, which, without significant added costs, provide blast protection of the order of 15 psi. In addition, fallout shelter approximately as effective as that resulting from the current shelter-marking and stocking program is provided for the remainder of the urban population, so that a total of 100 million people are given some form of fallout protection in each program (though the number of special shelter spaces is greater in Program B).**

Even Program A, the more modest of the two programs, offers substantial improvements over the unprotected case at low Soviet force levels. Neither Program A nor Program B alone can preclude substantial damage, given the Soviet preattack forces, as shown by the dashed lines in Fig. 9. With a force of roughly [redacted] warheads (or [redacted] equivalent warheads), the Soviet damage potential against the United States amounts to about 122 million mortalities with no improvements in defense; about 80 million with Program A; and about 50 million with Program B.*** The programs are necessary elements of a damage-limiting posture, but they require effective counterforce attacks to reduce the Soviet residual force to levels which they can handle effectively.

On the other hand, the assumptions of Fig. 9 may understate the effectiveness of the defense programs at low Soviet attack levels. The solid curves of Fig. 9 assume that the Soviets target to maximize population destruction. Where relatively few cities are protected by active defense, as in Program A, this means

*See above, note, p. 35.

**See Appendix E, Table E-2.

***These results are derived from an extremely primitive model of the effectiveness of a terminal defense system. The uncertainties about the design of the Nike-X system and its performance against various possible countermeasures do not appear to warrant a sophisticated model for the purposes of this report. The calculation is briefly discussed in Appendix E.

[redacted]

Fig. 9 — Improved defense and civil damage potential

avoiding the largest cities in favor of attacking the largest undefended cities. Specifically, this means that the Soviets do not attack Washington, D.C., New York, Chicago, and so on. However, if the Soviets plan a punitive strike, or one intended to disorganize the U.S. war effort, they might feel impelled to attack the largest cities, even if they had only small forces remaining. The broken curve of Fig. 9 illustrates the result if the Soviets try to assign at least 100 missiles to the 10 defended cities. When they have fewer than 100 missiles, the entire force goes to these cities. As the Soviet force increases this policy approaches the policy that maximizes population mortalities.*

This point is further illustrated in Fig. 10 which compares the Soviet damage potential under the conditions of improved (Program A) and unimproved defenses. Even at the 30 per cent level for SLMs at sea and with the larger U.S. missile force of the proposed USAF case, it takes both the missile wave and the bomber wave, as well as improved defenses, to get the Soviet damage potential significantly below 40 million U.S. deaths. With the 75 per cent level for SLMs, Soviet damage potential is reduced only to between 35 and 40 million by these measures. If, however, we also have some way to deal with the SLMs then the potential might be reduced to roughly 10 million after the U.S. bomber wave in the OSD case, or 6 million in the USAF case, as shown by the level of the dashed lines of Fig. 10.

To sum up the analysis of Soviet posture I, the programmed U.S. missile forces [redacted] The risk that the Soviets will launch substantial missile forces during the interval between U.S. missile and bomber impact is illustrated in Figs. 6, 7, and 10. The realized damage in

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*A related assumption implicit in the solid curves is that the Soviet damage potential after attack is calculated on the basis of perfect retargeting to maximize mortalities. The curves of Fig. 9 tend to be overestimates for this reason too.

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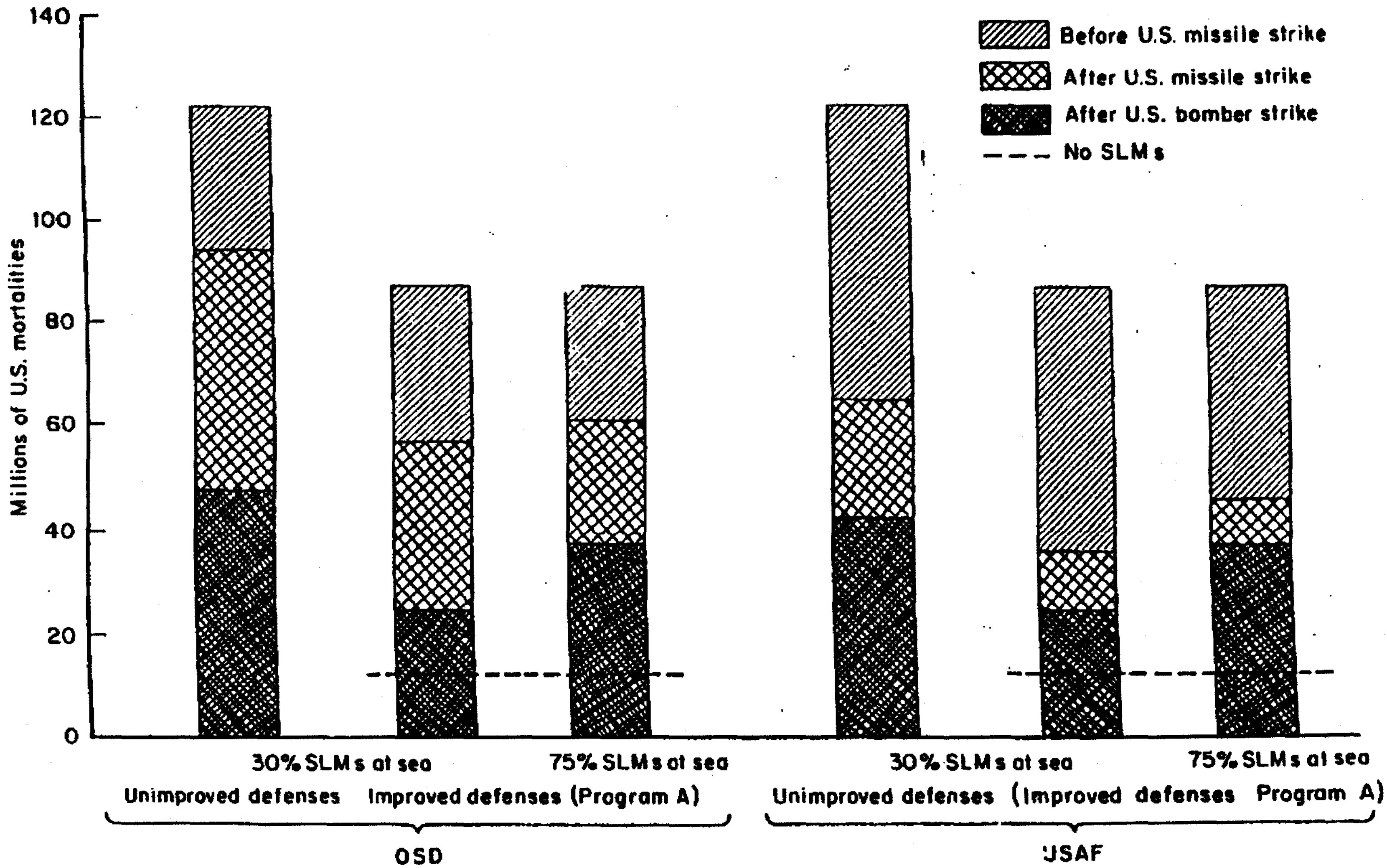

Fig. 10—Defense and the utility of counterforce
(Soviet damage potential versus the U.S.)

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the "S.U. strikes second" case of Fig. 7 shows the effects if the Soviets execute a military retaliatory strike in the interval: and the difference between the damage potentials after the U.S. missile strike and after the U.S. bomber strike shows the effect on the risk of a Soviet attack on population. The pin-down attacks by U.S. missiles to prevent Soviet missile launch until the arrival of U.S. bombers is discussed below.* Finally the possibility of a substantial force of Soviet SLMs at sea makes it necessary to add antimissile defense to U.S. counterforce capabilities if Soviet damage potential is to be reduced far enough to make the threat of U.S. initiation of a counterforce strike credible.

*See Section IV, "Missiles as a Pin-Down Weapon."

IV. SOVIET POSTURE II: DEFICIENCIES IN U.S. OFFENSE

IN THE PRECEDING SECTION, it was found that U.S. forces were adequate to execute a highly effective counterforce strike against Soviet fixed base installations of known location. Although bomber attacks were required to supplement the missile attacks against hard targets even with the USAF proposed force, it may be argued that larger or better forces (and not necessarily inordinately larger or better) would make it possible to rely on the missiles exclusively. Moreover, missile effectiveness might be enhanced by a shoot-look-shoot firing doctrine. However, before reaching conclusions, our uncertainties about Soviet posture ought to be taken into account. Soviet posture II reflects some of these uncertainties.

HOW HARD ARE SOVIET HARD MISSILES?*

The principal difference between Soviet postures I and II is the shift from the hard SS-7 to the SS-9 as the backbone of the Soviet ICBM retaliatory capability. As a result, posture II presents harder targets, and more of them, than posture I. We assume that the SS-9 is a Minuteman-like system. To illustrate the nature of our uncertainty about attacking hard targets, suppose that we knew the SS-9 was being built to the same blueprints and specifications as the U.S. Minuteman. We refer to it as a [redacted] system but this is its design requirement. To be sure, until some missiles in silos have been proof tested against nuclear attack, it will be uncertain whether the design goals have been met. If the designs have been successful, a (b)(1),(b)(3):42 USC §2168(a)(1) system is one where a very large fraction of the

*This Section draws on work by M. Arnsten. For a partial report of this work see M. Arnsten, Shoot-Look-Shoot at Hard Targets (U), The RAND Corporation, RM-3614-PR, August 1963 (Confidential).

Minutemen are expected to survive the incidence of [redacted] overpressure. But we require a damage criterion that gives us high confidence that a large fraction of the missiles attacked have been destroyed. In general. the probability that a structure has been destroyed by a nuclear attack declines as the distance from ground zero increases and the overpressure decreases. Figure 11 illustrates this relationship for a "Minuteman-like" target. using data from an Air Force Manual* prepared as a guide to target planning. The criterion of destruction in the manual is fracture of the door slab.** The [redacted] destruction point implies greater hardness than the nominal [redacted] usually associated with Minuteman system as a whole. Figure 11 also shows that. after an attack in which we have observed the miss distances of our offensive weapons [redacted] Miss distances between the design point distance and the point at which failure is certain permit us to say only that the target may be dead or alive, and perhaps to assign some figure of probability to its state.

This view of the vulnerability of hard targets also affects the usefulness of bomb damage assessment data used in shoot-look-shoot tactics. The object of such tactics is to increase the efficiency with which our missile systems are employed by firing sequentially at each target. and stopping when observation shows that the target is destroyed. On the average this takes considerably fewer missiles than firing a salvo large enough to achieve the desired probability of destruction. The extreme left bar of Fig. 12 shows that with a weapon system having a single shot kill probability of 0.46. the shoot-look-shoot tactic requires only about one-quarter as many shots as the salvo tactic to achieve a probability of destruction of 0.99. However, this result assumes that each look at a target tells us unambiguously whether the target has survived or not. and that we can shoot and look as many times as necessary to destroy the target. But the kind

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*AFM 200-8. pp. 1-29. and associated charts and nomograms. The overpressure for a given probability of destruction is yield sensitive. Those quoted are for [redacted] weapons.

**Information made available after the completion of the calculations in this report indicates that the door on the Minuteman might become inoperable at lower overpressures than suggested in Fig. 11, but still higher than the nominal system hardness.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

Fig. 11 —— Vulnerability of a Minuteman-like target to a (b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD) weapon

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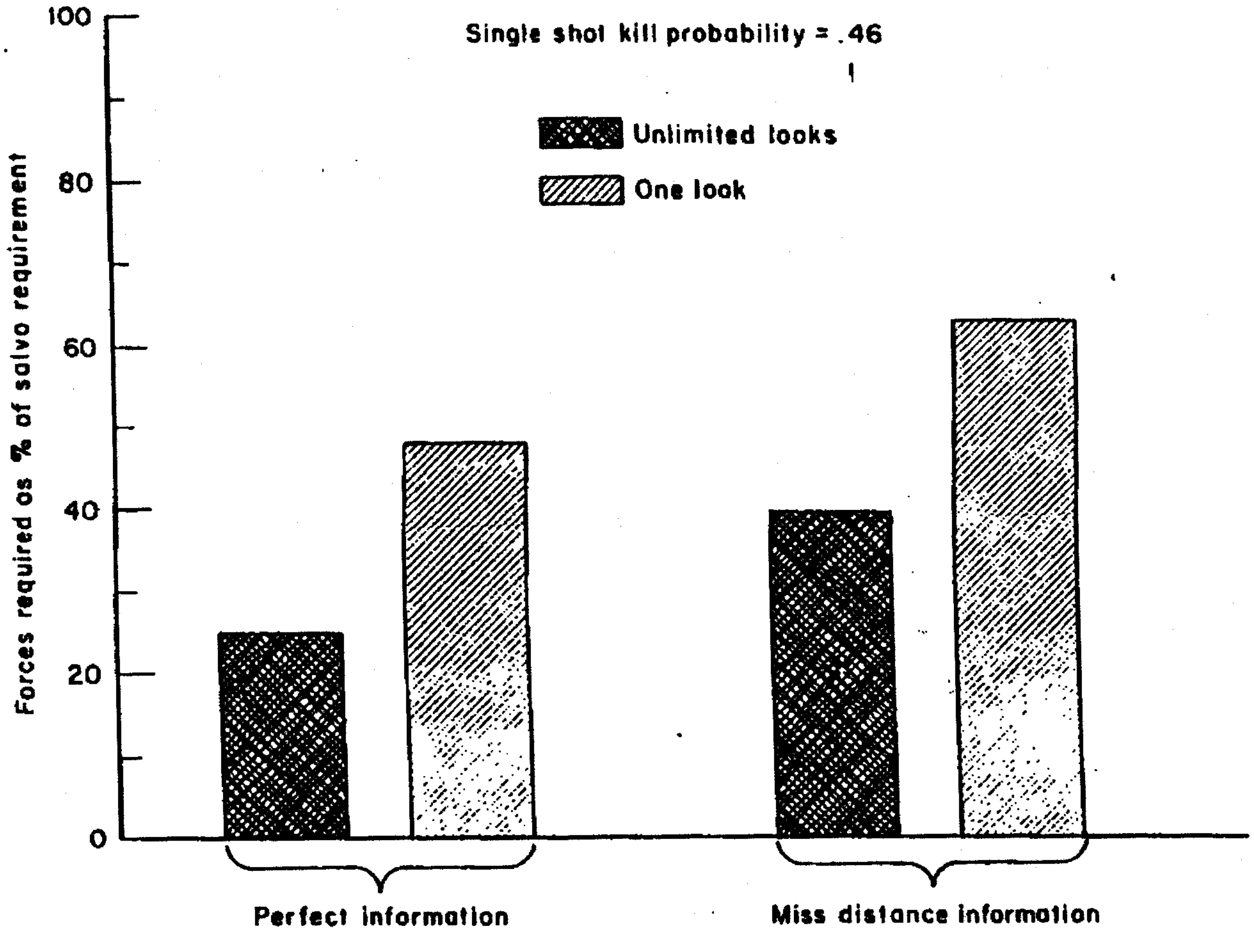

Fig. 12 — "Shoot-look-shoot" tactics
(offensive force requirements for 99% destruction)

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of bomb damage assessment we are capable of doing is likely to yield only miss distance information. With a vulnerability relationship like that of Fig. 11, the force requirement with the shoot-look-shoot tactic is about 40 per cent of that for the salvo tactic according to Fig. 12. If we also limit ourselves to achieving the required probability of destruction by shooting, looking only once, and then shooting again to complete the counterforce campaign quickly,* the force requirement is about 65 per cent of the salvo requirement instead of the substantially smaller 25 per cent suggested by the oversimplified view of this problem.

The discussion so far suggests that even if we had as much information about Soviet missiles as we have about our own, conservative attack planning would require that we consider them tougher than their nominal hardness. In part, this is because the curve of Fig. 11 (and the planning data of AFM 200-8) takes fracture of the Minuteman door slab as the criterion of destruction. Other damage effects -- failure of the shock isolation system as a result of ground shock, and electromagnetic pulse effects -- are explicitly excluded. The curve of Fig. 11 almost certainly underestimates the vulnerability of the system. Presumably, then, the door slab criterion was chosen because, unlike the other effects, it was well enough understood to permit calculation and postattack verification. It is conceivable that proof testing could improve our estimate of the vulnerability of our own missiles. When we turn to Soviet missiles, however, and consider what information might be available to us, it is unlikely that our estimates will be as good as those in AFM 200-8. Ignorance may compel us to take a very conservative view of the vulnerability of Soviet missiles. We reflect this by assuming that the VN associated with the curve of Fig. 11 characterizes the vulnerability of the SS-9.**

USAF PROPOSED POSTURE AGAINST SOVIET POSTURE II

The expected outcome of a U.S. counterforce strike is strongly affected by the Soviet shift to the SS-9 and by the conservative targeting criterion discussed

*Using as many shots in each round as necessary to achieve 99 per cent destruction, on the average.

**Although we continue to treat the hard SS-7 as a [redacted] this does not imply that we believe our estimates of SS-7 hardness are exempt from the considerations discussed above.

above. The U.S. missile wave is far short of completing the counterforce attack. Figure 13 shows [redacted] Against Soviet posture I. the job could be done even with the [redacted] CEP: but this accuracy is quite inadequate to achieve high effectiveness against Soviet posture II. If all the bombers were allocated to attacking the SS-9s they could destroy [redacted] of the targets with a [redacted] CEP. even with shoot-look-shoot tactics. Apart from the uncertainty about target vulnerability, the usefulness of shoot-look-shoot tactics is reduced by the added exposure of the bombers to defenses deployed at the target sites. Increased effectiveness as a result of shoot-look-shoot tactics implies that sometimes a bomber will penetrate to a target through defenses. look. decide that it is not necessary to reattack. and proceed to another defended target. It will thus be exposing itself to a greater number of SAM batteries in the course of dropping its bomb load.

If the B-52s can achieve a 1,500 foot CEP. their performance against Soviet posture II is greatly improved, but still leaves much to be desired. The bomber attack outcomes summarized in Fig. 13 are based on a [redacted] CEP. Two attack levels are shown. The smaller employs 250 B-52s. half of the generated force or more than 80 per cent of the ground alert force. and is by no means adequate. Nearly [redacted] ICBMs can be expected to survive. The larger attack, employing all 500 combat ready B-52s. destroys about [redacted] of the hard missile targets. With shoot-look-shoot tactics. about 480 B-52s are required for this level of destruction. At this level of destruction the benefits of shoot-look-shoot are marginal without attrition: attrition effects reduce the benefits to negligible proportions.

Figure 14 shows the civil damage implications of varying the B-52 attack levels. Surviving Soviet forces are translated into their damage potentials. We have not. of course. tried to establish an optimal exchange ratio between reductions in damage potential and B-52s allocated to this mission. Nevertheless. the slope of the curve serves as a crude measure of the completeness of any attack level. So long as the curve is declining steeply. there are still opportunities to limit damage by counterforce. If the solid curve of Fig. 14 (which

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[redacted]

(b)(1),(b)(3) 42 USC §2168(a)(1)(C) (FRD)

Fig. 13 — Residual forces in a U.S.-initiated attack, 1970
(USAF proposed force versus SU posture II)

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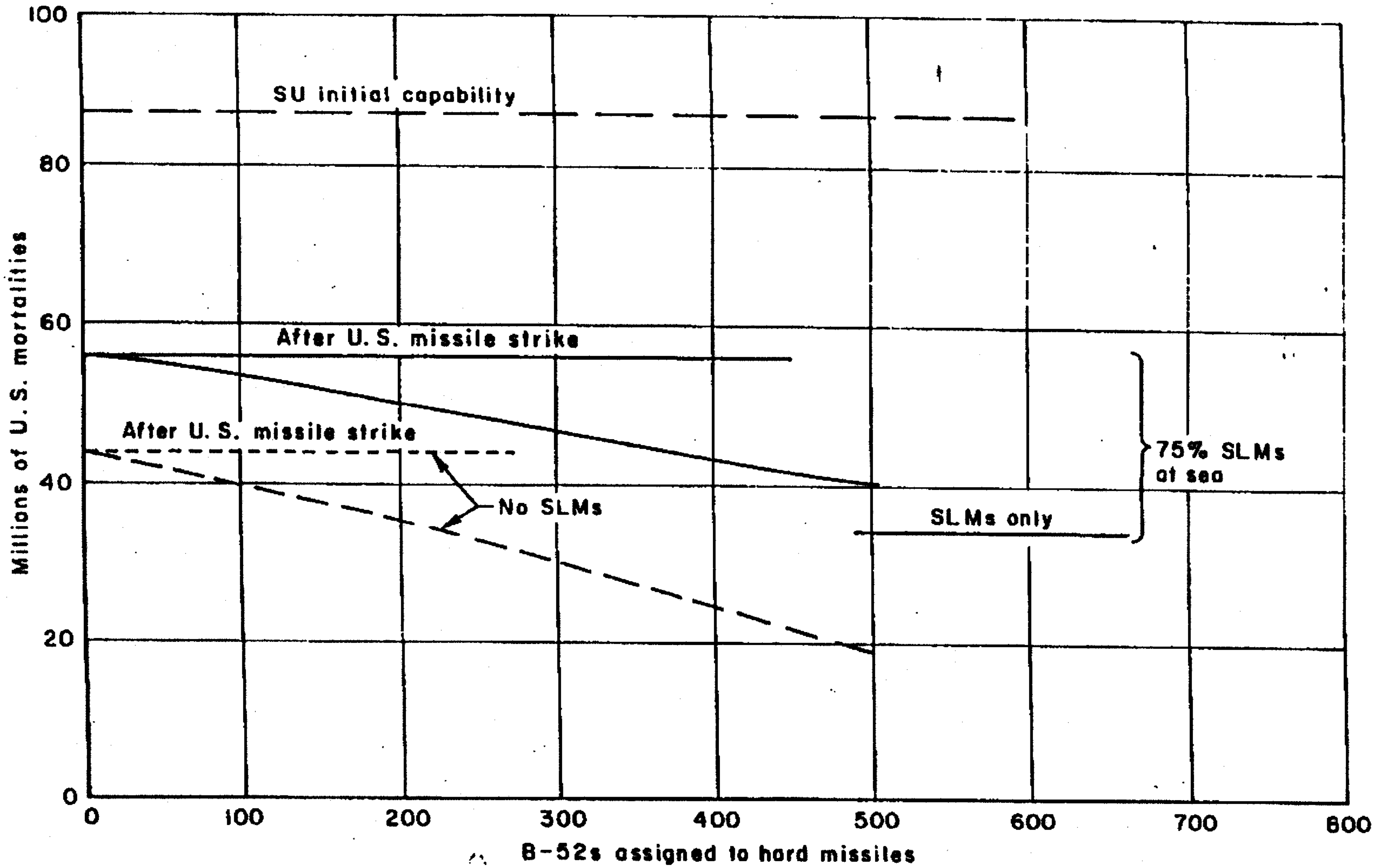

Fig. 14 — Reducing Soviet damage potential by B-52 attacks
USAF proposed posture with defense program A versus SU posture II

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shows Soviet damage potential with 75 per cent of their long range SLM force at sea) were extended somewhat further, it would flatten perceptibly, becoming asymptotic to the horizontal line marked "SLMs only." In the absense of the *SLM threat, the flattening would not take place until the* B-52 force had been greatly increased, and it would take place at a much lower level. The dashed curve of Fig. 14 illustrates the situation without SLMs: and this curve would become asymptotic to the horizontal axis. In the absence of some means of dealing with SLMs, increasing our counterforce effectiveness against the fixed base ICBMs may not offer much reduction in Soviet damage potential. But if we include a defense against the SLMs, our incentives to increase our counterforce effectiveness against the rest of the Soviet threat rises sharply.* This is another illustration of the complementarity among damage-limiting measures.

In one important respect, the results of Fig. 14 may be over-optimistic for counterforce. We have ignored the operational difficulties the B-52s might experience in attacking (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) [redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) [redacted]

Figure 15 summarizes the results of attacks against Soviet posture II in terms of the civil damage implications. In addition to the points covered previously, it shows that collateral damage to the Soviet Union will be greater in posture II than in posture I. *This strengthens the doubts* about the adequacy of the U.S. coercive capability represented by Polaris alone to deter the Soviet Union from countercity attacks. Coupled with the requirement to use large fractions of the B-52 force in counterforce attacks, this deficiency stresses the *importance of a dispersal and recovery capability for the bomber force.*

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*Perfect defenses against SLMs are no more likely than against other nuclear delivery vehicles. However, there are promising ideas for such defenses (see pp. 42-44), and Fig. 14 also suggests the importance of pursuing them. Figure 14 is not meant to suggest that increasing the number of B-52s is a preferred way to increase counterforce effectiveness against hardened targets. Some means are discussed below (p. 62).

**These are the preliminary results of a current RAND study of this problem by Merrit W. Olson.

[redacted]

Fig. 15 — Civil damage — USAF proposed force versus SU posture II
(improved missile defenses)

<u>IMPROVING OFFENSE CAPABILITY</u>

The discussion so far has suggested (b)(1) [redacted]

(b)(1),(b)(3):42 USC §2168(a) (1)(C)--(FRD) [redacted]

Table 3 presents some improvements to U.S. offensive forces and very rough estimates of their five year costs.* It also recapitulates the material covered earlier on defense. The offensive force improvements listed are by no means the only ones that merit consideration. They have been chosen for their relevance to the analysis of this report.

MISSILE IMPROVEMENTS

The most important improvement we might achieve in U.S. offensive missiles would be an increase in their effectiveness against hard targets. This implies greater accuracy or more effective warheads. With respect to accuracy, improvements can be expected and are worth trying for. However, the prospects for improving inertial systems or developing map matching terminal guidance for ballistic missiles are not sure enough to rely exclusively on achieving CEPs (including non-guidance errors) [redacted] for the missiles that come into our operational inventory in the early 1970s. Guidance error alone may be reduced well below this level, especially with some types of mid-course radio guidance being considered, but these extremely accurate guidance systems might present greater operational complexity. In any case, nonguidance errors of uncertain magnitude would remain.

More effective warheads are also a possibility. Increase in the yield alone to achieve greater lethal radii appears to be relatively unrewarding against very hard targets, and, if it implied a corresponding increase in the surface burst fission yield, it would also result in undesirably high collateral fallout damage to [redacted] A recent analysis suggests that [redacted] (b)(1) Penetration bursts offer the possibility of increasing ground shock to levels that may offer considerably greater kill

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*The cost estimates have been taken from the SAFE Game menus. See O. Helmer and T. Brown, Safe: A Strategy and Force Evaluation Game (U), The RAND Corporation, RM-3287-PR, Amended February 1963 (Secret), pp. 63-87.

**F. Shelton, B. Evans, and D. Sachs, A Study of Air Blast Phenomenology in the Very High Pressure Region (U), Kaman Nuclear Report, DASA 1331, October 1962 (Secret-Restricted Data).

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Table 3

PRINCIPAL IMPROVEMENTS FOR U.S. STRATEGIC FORCES

Force	Approximate 5-year Cost ($ billions)
OFFENSE	
Missiles	
Reliability monitoring	<0.1
Payload flexibility	?
Pin-down	?
Bombers	
B-52 Recce-strike Mod	1.5
High-resolution sensors	
Short-range ASM	
Clam	1.5
Improved post attack dispersal and recovery	1.0
DEFENSE	
Deployment of "effective" Nike-X	13.0
Airborne anti-SLM program[a]	2.0-10.0
Larger and better fallout shelter program	9.0

Note:
[a] Depends on range of Soviet SLM and type of U.S. aircraft used.

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effectiveness against [redacted] However, without considerably more knowledge of the response [redacted] (b)(1) it may be impossible to estimate the effectiveness of such techniques reliably. To rely on kill mechanisms other than destruction of the protective structure, it may be necessary also to get more experimental evidence on the response of complex targets to nuclear attack.

Although the prospects for drastic improvement of missile performance against hard targets are not reassuring, there are several improvements that might enhance their capabilities for other parts of the counterforce task. Against soft targets, (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) [redacted]

In addition to some means of observing and reporting the success of the missile launch, a "launch, monitor reliability, launch (if necessary)" policy also requires great retargeting flexibility. An explicit guidance technique that provided unlimited retargetability* would greatly enhance the usefulness of a missile reliability monitoring scheme. Unlimited retargeting capability would, of course, make the force somewhat more flexible than, say, a capability to store eight targets in each missile: but the primary benefit would be the simplification of the command and control procedures. With the ability to send any one of a

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RAND has suggested to the Air Force that such capability be included in Wing VI and subsequent Minutemen. This capability is also discussed in John Bower, Estimate for the ICBM Requirements for Counterforce: The Relation of Size and Numbers to Guidance Accuracy and Flexibility (U), The RAND Corporation, RM-3782-PR, forthcoming (Secret-Restricted Data). Explicit guidance would require only that target coordinates be fed into the missile; this could be done by remote control. [redacted] (b)(1) large number of missiles to any one of a large number of targets, it would be unnecessary to keep track of all the undestroyed targets stored in all the remaining missiles. It would suffice for the commander merely to call for a reliable missile on a specified target.

Missile performance against soft, collocated targets can also be improved. [redacted] The damage could be reduced without diminishing the assurance of coverage, even against area targets, by the use of clusters of small yield weapons. [redacted] dispersed in a pattern provide essentially the same coverage against an average airfield as a (b)(1),(b)(3):42 USC §2168(a)(1)(C) -(FRD) delivered with the same CEP, and do considerably less damage to nearby cities or their suburbs.**

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*The problem of achieving efficient retargeting with a limited number of missile target options is highlighted by considering the simplest such problem, the decision to strike a single target with a single missile. With unlimited retargetability the decision would hinge on whether the target was worth a missile. An estimate of the total number of missiles remaining would be the most important force status question involved. Once it was decided that the target was worth a missile any ready missile could be ordered on the target. With limited retargetability it would also be necessary to find some missiles with the given target as one of their options. But in deciding which, if any, to fire, it would also be necessary to ask if firing a particular missile might not degrade our capabilities at one of the other targets in its option list. The answer depends on the importance of each of these other targets, the availability of other missiles to cover them, the other options of the other missiles, and so on. Moreover, the optimal allocation depends on random variations in the course of the launch, look at reliability, launch sequence. The choice in any given round of firing must take into account the large number of possible outcomes in future rounds. The problem is thus a many dimensioned dynamic programming problem. Although this web of considerations could not be allowed to expand indefinitely, it is not at all clear that a satisfactory compromise between efficient use of the force and complexity of the allocation process can be made with limited retargetability. The existence of feasible and near-optimal allocation rules for the limited retargeting case has not yet been established. In the absence of unlimited retargetability this is an important task. See Appendix G for an analysis of one feasible allocation rule, which turns out to be significantly less than optimal.

**See D.C. McGarvey, <u>Collateral Damage Data and Comments</u> (U), The RAND Corporation, RM-3685-PR, forthcoming (Secret-Restricted Data).

MISSILES AS A PIN-DOWN WEAPON

The importance of a pin-down capability comes from missile ineffectiveness against hard targets on one hand and the long bomber time to target on the other. In a variety of contingencies of outbreak, the time difference between missile and bomber arrival might permit Soviet missile launch, even allowing for some breakdowns in Soviet command and control. The Russians, seeing a large-scale counterforce attack, knowing that many of their hard missiles survived the U.S. missile attack, and expecting the imminent arrival of the U.S. bomber attack, would feel strong pressure to respond quickly, perhaps without much discrimination between military and civil targets. The pressure would be reinforced by any doubts about the target objectives of the bomber force.

At this juncture, coercion of the Soviets will be put to its most severe strain. Later, the nature of the U.S. attack is likely to be clearer and the relative military balance presumably will have shifted further in favor of the United States. Soviet initiation of countercity attacks would be an act of desperation in any case: but acts of desperation are most likely in the presence of great uncertainty, when the alternatives are unclear, and then they can be rationalized in terms of a seeming self-interest. All these conditions are met most fully while the U.S. counterforce attack is still in process, less so after the bulk of the attack has been executed. Coercion has little chance of working during the course of the U.S. attack unless the ability and intention of the United States to fight a controlled war have been conveyed unambiguously to the Russians during peacetime. It also requires a devastating U.S. reserve capability against Soviet society that can be held in reserve for use only if the Russians precipitate a civil exchange.

U.S. first-strike damage-limiting capability would be less risky and less subject to Soviet bluffing if reliance on coercion for the critical period between missile and bomber arrival could be reduced. A pin-down capability that left the Soviets unable to fire their surviving ICBMs for some period after a U.S. missile attack would therefore be a great contribution. Its value is reflected by the difference between Soviet damage potential immediately after the missile attack and after the bomber attack.

Pin down might occur for a variety of reasons. Depending on the nature of the Soviet command and control system, about which the authors have no detailed information, attacks on certain [redacted] might produce this [redacted]

However, none of these possibilities is sufficiently reassuring to permit complete reliance upon it. A thermonuclear land mine is an illustration of further possibilities for a pin-down capability. Such a device may be delivered by missiles and would consist of a nuclear warhead able to penetrate and bury itself shallowly in the vicinity of Soviet ICBMs. [redacted] by a combined acoustic-seismic sensor that could discriminate [redacted]

If the Soviets were unaware of the device, or if they discounted its effectiveness, they would presumably [redacted]

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*The targeting criterion for reliable kill is explicitly conservative; consequently the U.S. missile attack might actually have killed many more Soviet missiles than we would know about. For this reason, the inability to achieve high confidence of hard target destruction should not lead us to abandon this element of the attack. Each Soviet missile should be targeted by at least one reliable U.S. missile in case they are much softer than we can assume.

**There do not appear to be reliable data on the distribution of debris for various depths of burst. Reliance on a penetration burst would depend on better information about ground shock and debris distribution and about the design of Soviet missile shelters as well.

***E.C. Heffern, A Possible Use of a Thermonuclear Land Mine (U), The RAND Corporation, RM-3590-PR, May 1963 (Secret-Restricted Data). [redacted] Further investigation of ICBM launch acoustics is necessary to verify these results and has been recommended to the Air Force by RAND.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) [redacted]

BOMBER IMPROVEMENTS

The yield. CEP. and load carrying capabilities of the B-52s are essential to achieve high effectiveness in counterforce attacks and to provide a large enough residual threat against Soviet cities for continued coercion of the Soviets. However. the current capabilities of the B-52s carrying free fall bombs are marginal against Soviet posture II. even under optimistic operational assumptions. One way to obtain improved performance would be to modify the B-52s to a "B-52 recce strike" (RS-52) configuration.* The basic changes include provision of a high resolution radar and of short range air-to-surface terminal missiles. In combination, these permit the bomber to achieve very great accuracy. At short ranges. systems of this sort may provide a CEP significantly [redacted] feet by the end of the sixties. With very great accuracy. high kill probabilities can be achieved even against very hard targets with relatively low yields. We assume that the B-52 recce strike system has a CEP of [redacted] feet and a yield of [redacted] But the small warhead and short range of the air-to-surface missile permit a small missile, and each aircraft can carry a large number of them. Studies indicate that a B-52 could carry as many as 32 ASMs.** We assume 16 per aircraft. The low yield also serves to reduce collateral damage from counterforce attacks.

Another benefit from the recce strike version of the B-52 is its improved performance against the low altitude SA-3. Instead of having to rely on the limited number of rather large Hound Dogs for supression of SAMs defending hard targets. the RS-52 can attack hard targets while staying out of range of SAMs. or attack the SAMs first and then approach the target more closely (if extreme accuracy

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*E. P. Oliver, Summary Report on a Study of the Penetrating Manned Bomber (U), The RAND Corporation, RM-3183-PR, December 1962 (Secret-Restricted Data). pp. 83-94. Such a modification was found to be a feasible and desirable improvement to the B-52 in this study.

**Ibid., Fig. 9, p. 91. The figure shows the numbers of ASMs in one of a B-52's two weapons bays.

were required or if there were some uncertainty regarding target location, making it desirable to see the target directly with the high resolution radar rather than use an offset aiming point). In the standoff mode, the RS-52 also avoids the operational problems encountered in multiple weapon attacks on dense missile fields such as U.S. Minuteman complexes.

In addition to the short range air-to-surface missiles for attacking hard military targets, a longer range air-to-surface missile might be useful in increasing the ability of the B-52 to penetrate to heavily defended [redacted] enhancing the threat value of this part of the force. One such system is the CLAM,* a chemically powered low altitude supersonic missile. But most of all, if the B-52s are to supplement the deficient threat capabilities of withheld missiles, it is necessary that they be kept operational or recycled after the counterforce strike. At present, [redacted] Various schemes for enhancing the post-attack operational status of the B-52s have been studied and appear to offer considerable prospect for maintaining capability in the face of enemy attacks involving hundreds of missiles against dispersal fields.**

We have referred so far to improvements in B-52 capabilities. The B-52G and H models, at least, appear to have sufficient service life remaining to warrant modifications to improve their operational usefulness. Yet there are various reasons for considering a follow-on aircraft at this time.

Analysis of the penetration problem suggests that appropriate tactics involving defense suppression and evasion have good prospects for maintaining a satisfactory capability into the 1970 period.*** The choice between low-altitude subsonic and high-altitude supersonic penetration will be sensitive to the nature of the Soviet 1970 defense posture, but there are reasons for favoring low-altitude penetration

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*Ibid., p. 82.

**See R. C. Kao, B-52 Protection In a General War, 1965-1970 (U), The RAND Corporation, RM-3697-PR, forthcoming (Secret-Restricted Data); E. P. Oliver, op. cit., pp. 21-35.

***F. A. Tatum, A Discussion of Manned Bomber Penetration Measures for the 1960s (U), The RAND Corporation, RM-3299-PR, November 1962 (Secret), pp. 99-100.

at this time.* And the state of the art currently offers low-altitude aircraft with other attributes that would make them operationally superior to either the B-52 or to a high-altitude supersonic aircraft.**

Perhaps most important among these attributes is the greater adaptability to continued postattack operations. Longer range than even the B-52H would permit reduced reliance upon tankers and overseas recovery bases for round-trip missions. If, instead, there were a great premium on the flexibility derived from the ability to operate from any of a large number of fields (sacrificing, however, round-trip intercontinental range), a long-range attack aircraft (LRA) with V/STOL capabilities and good low-altitude penetration characteristics can be developed.*** If the B-52G and H are to be kept in the force for a considerable period, the LRA might be a useful addition, offering a mix of penetrating aircraft with intercontinental range and flexible postattack operational capabilities. Both the possible long-range low-altitude aircraft and the LRA could carry payloads of the sort discussed above for the RS-52. And these aircraft, designed for low-altitude operation (as the B-52 was not) would also offer greater speed and stability at low altitude. If some portion of the LRA force could be deployed overseas, at least in crises, it would also significantly reduce the response time of the bomber force.

The role of penetrating aircraft in our prospective counterforce capability is so important, the lead time for new aircraft is so great and uncertain, and the structural life of the B-52 is sufficiently uncertain to warrant early inception of development programs for one or more follow-on aircraft. The sensor and terminal missile package discussed above should be developed concurrently and be capable of being carried on the follow-on aircraft as well as the B-52.

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*Ibid.

**E. P. Oliver, pp. 95-100; and R. Schamberg and C. M. Weber, Long Range Attack Aircraft with V/STOL Capability (U), The RAND Corporation, RM-3725-PR, forthcoming (Secret).

***Such aircraft might be developed primarily for their usefulness in limited war roles, but might also perform a valuable function in general war strategic operations and especially in the later phases of a general war.

THE COSTS OF THE ADDITIONAL PROGRAMS

Table 3 shows the five-year systems costs of some of the additions to current programs which have been discussed and suggested. The distribution of these costs over time are somewhat more relevant to the decisions about implementing these programs. There are, however, a number of factors that make it difficult to present reliable phased costs in this report. The direct systems costs themselves are quite uncertain for some of the largest elements of cost, particularly Nike-X. It will probably be very difficult to make a good estimate of the cost of providing an effective defense of a given number of urban areas (or perhaps whether such a defense is feasible at all) until the development program has proceeded further. In addition, the distribution of costs over time is dependent on how fast development programs go forward, on the timing of decisions to implement the programs, and on the priority assigned to them.

Despite the uncertainties, we have made a crude estimate of the phased costs of the programs shown in Table 3. The estimate indicates that the programs can be carried out at a level of spending for OSD Programming Packages I, II, and civil defense which remains roughly at its present level through 1970. This assumes that appropriate development activities are begun or continued in 1965, that it is possible to begin procurement of Nike-X and the RS-52 modification in 1968, and to begin procurement of CLAM in 1969, that an airborne anti-SLM system close to the lower end of the range of costs is chosen, and that procurement is initiated in 1966; and finally, that the civil defense program is accomplished during the period 1966-1969.* Unless those parts of the program that can be accomplished early are undertaken as soon as possible, there will either be a lumping of the costs late in the period or capabilities will not be available until after 1970. In making these estimates we have not allowed for the elimination of elements of current programs that might be rendered superfluous by the suggested changes and that could result in savings in the missions concerned.

*No estimate for procurement of a follow-on aircraft is included in these estimates.

IMPROVED OFFENSE FORCES AGAINST SOVIET POSTURE II

The results of improving the strategic offensive forces are shown in Figs. 16-18. *The U.S. missile attack now assigns* (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) (b)(1),(b)(3):42 USC §2168(a)(1)(The target system for Soviet posture II contains somewhat fewer than [redacted] and about [redacted] The number of U.S. missiles required to cover this target system with one reliable warhead. and *also to deliver* a *thermonuclear* land *mine* for each hard missile launcher. depends on more precise characteristics of the thermonuclear land mine (its weight and shape) than have yet been determined and on the reliability of the boosters. Soviet posture II contains [redacted] With the missile reliabilities assumed (Appendix B). *it would take a force greater than the USAF proposed* force to cover each aim point with one normally fused thermonuclear warhead. and each hard missile launcher with one thermonuclear land mine. if each warhead and land mine required a separate booster. If it were possible to deliver more than one land mine with a booster or to piggyback a land mine with a *normally fused warhead. the requirements might be substantially* reduced. However. the numbers are chosen for illustration and do not constitute a requirement until we have better evidence of the nature and size of the Soviet missile force buildup. The decision on U.S. missile force size can to some extent be made as we go. and it is not necessary to decide now *on the precise composition of the* 1970 force. Still. this illustration suggests that it is useful to have a missile with a large enough payload to permit some flexibility in the choice of warheads. Figure 16 shows the results of an attack in which the bulk of the U.S. ICBM force and half of the U.S. Polaris force is fired in the initial missile wave. The more *effective* bomber *payload* reduces *the fraction of the bomber force required.* and attrition is lower because the bombers are no longer exposed to unattacked SAMs. The bomber force is capable of very high effectiveness against Soviet [redacted] leaving very few of them surviving after the bomber attack.

Figure 17 shows the civil damage implications *of the strike. The Soviet damage potential* against the United States illustrates the importance of the pin-down tactic and the bomber follow-on. After the missile wave the expected Soviet-damage potential is almost 60 million deaths. After the bomber follow-on it is

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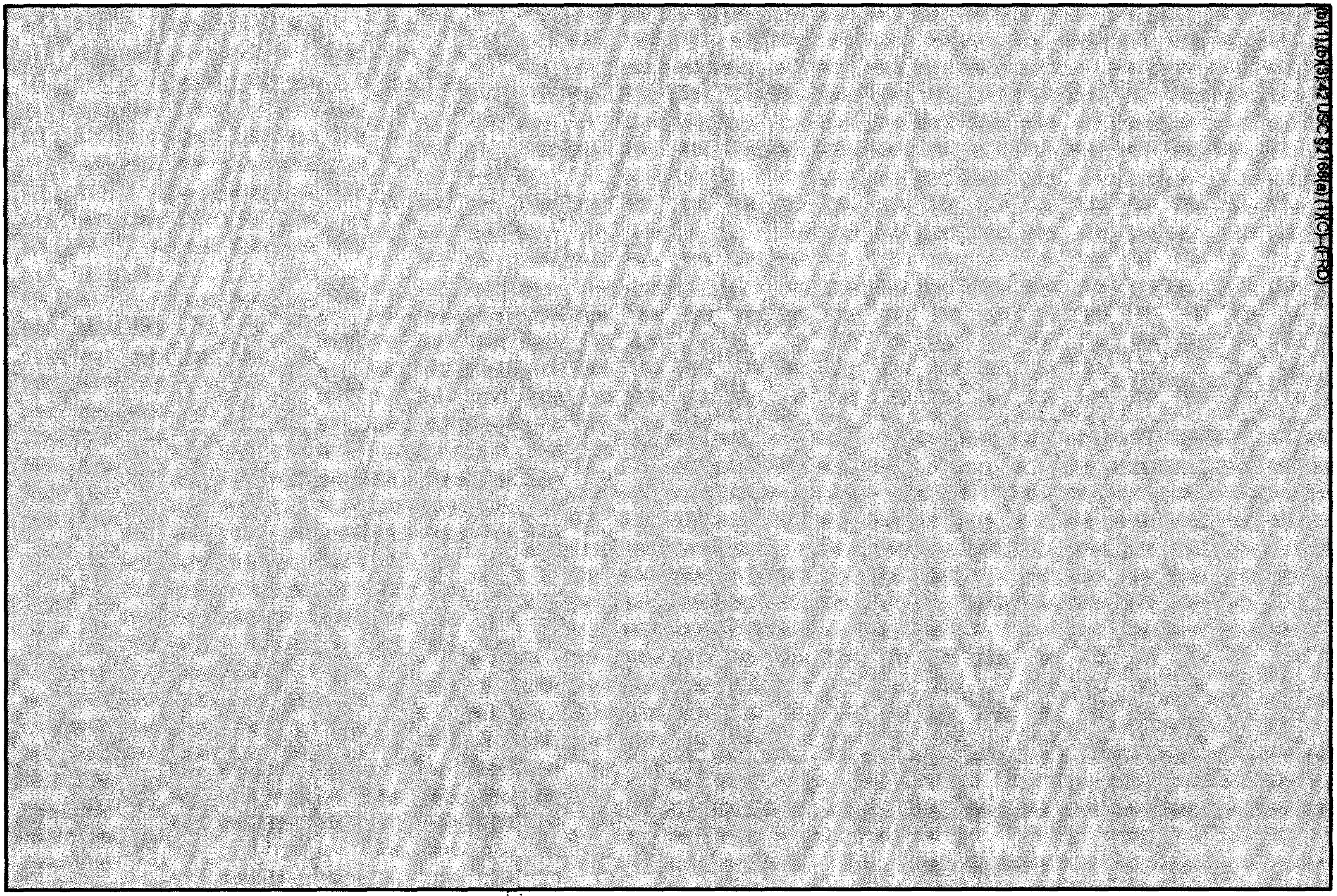

Fig. 16 — Residual forces in a U.S.-initiated attack, 1970
(improved U.S. forces versus SU posture II)

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(b)(1),(b)(3) 42 USC §2168(a)(1)(C)-(FRD)

[redacted]

Fig.17—Civil damage—improved U.S. forces versus SU posture II

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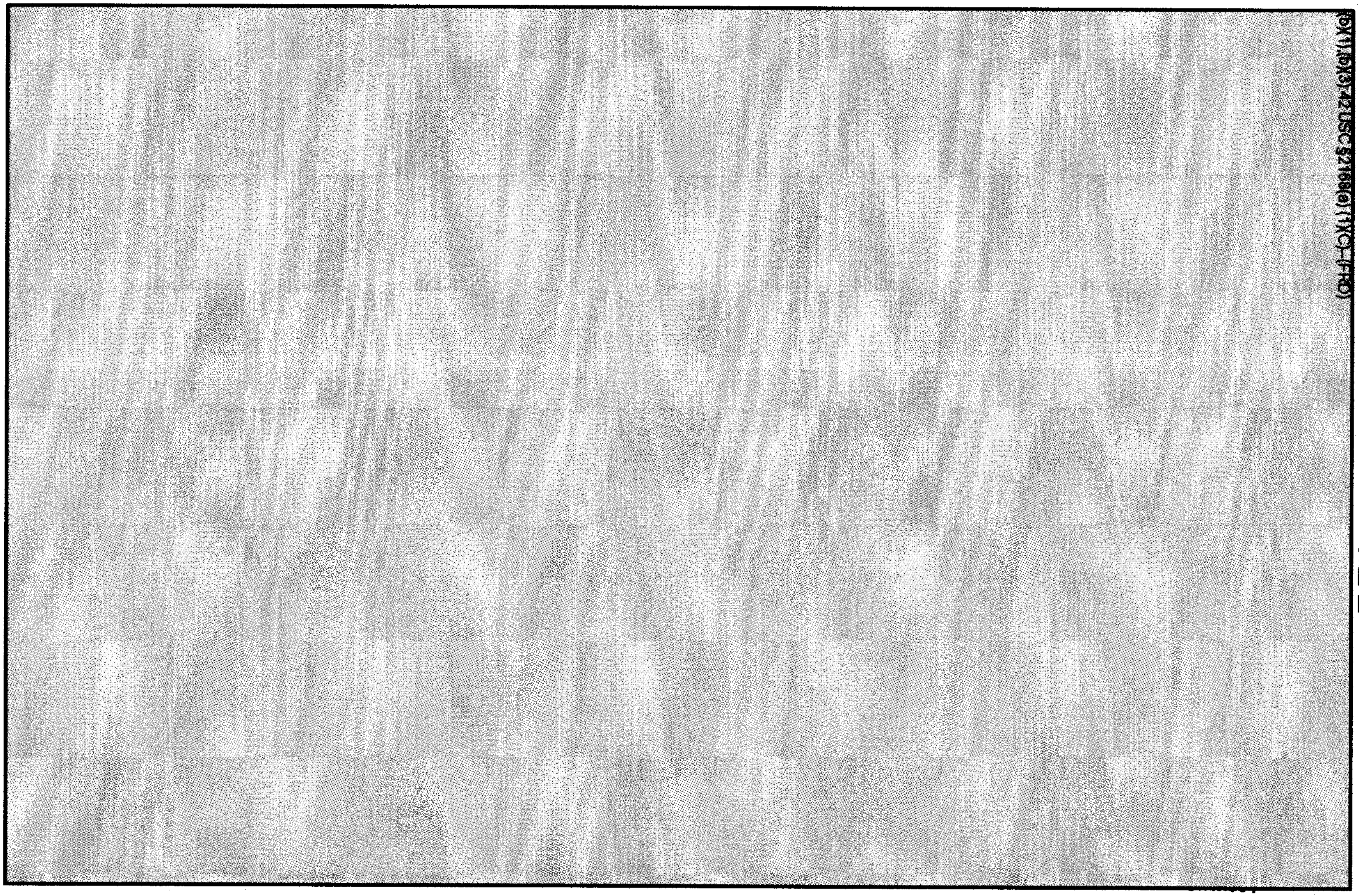

Fig.18—Soviet counterforce reaction
(U.S. civil damage with improved U.S. forces, SU posture II)

[redacted]

reduced to [redacted] depending on the size of the Soviet SLM force at sea if nothing is done about the SLMs, and less than [redacted] if the SLM threat were eliminated. The Soviet threat against Europe, though much lower than before, is still high, principally because we do not assume improved defenses for Europe. However, the relative damage potentials after the attack are sufficiently favorable to the United States that it has a good basis for a credible coercive threat against Soviet initiation of countercity attacks against Europe as well as against the United States. Moreover, the collateral damage to the Soviet Union is considerably less than in the preceding attacks, permitting the Soviets to take a more dispassionate view of their own self-interest. The realized damage shown in Fig. 17 consists mainly of fallout deaths. If airbursts or clean weapons were used against hard targets, the mortalities would be reduced to [redacted]

The results in the event of a Soviet counterforce response to the U.S. strike are also considerably improved by the combination of changes as shown by Fig. 18. If the Soviet strike gets off before the impact of U.S. missiles, the damage to the U.S. is reduced by the combination of active and passive defense. Even the mixed Soviet counterforce-countercity strike, masquerading under the guise of an attack on the economic capacity of the country, though terribly destructive, is not so damaging as to make relatively quick recovery impossible for the nation (Appendix F). The Soviet damage potential after their preemption and the U.S. counterforce attack is quite low.

If the Soviet counterforce strike does not get off until after the impact of U.S. missiles, the pin down attack can limit the damage to what can be done by the Soviet SLMs. In this case, perhaps the most likely of those considered, the <u>total</u> of realized and potential damage to the United States, is on the order of [redacted] and could be reduced by a defense against SLMs.

V. SOVIET POSTURE III

SOVIET posture III is designed primarily to provide a secure retaliatory capability. To that end, unsuitable systems currently coming into the Soviet inventory are quickly phased out and replaced by missile systems protected by very hard structures, concealment, or mobility. In addition, the antibomber defense also stresses survival against the U.S. attack by means of dispersed local defenses and mobile area defenses provided by an MPLE-Eagle type of autonomous interceptor.*

We chose this posture to illustrate the proposition that neither known technological constraints nor likely resource level constraints can keep the Russians from achieving a very secure offensive force. Systems now in the U.S. inventory or that might come into it in the early seventies cannot, against this posture, (b)(1) [redacted] We present no calculations of the results of a counterforce strike against Soviet posture III. Attacks on the fixed base missiles can be shown to be much more difficult against posture III. The targets are harder, and the bombers are opposed by an area defense that cannot easily be destroyed. The advantage of increasing the number of weapons carried by each bomber is very sensitive to the expected attrition. But even if many of the hard missiles are destroyed, there will still be large, powerful, mobile and concealed Soviet forces. Calculations would show virtually all the deployed elements of these forces surviving the kind of counterforce attack we know how to describe now. Airborne anti-SLM defenses would probably be infeasible against Soviet submersible barge-based missiles in inland Soviet waters (especially in the presence of Soviet area defenses); and they would become increasingly costly if SLM range increased as it might with more sophisticated

*Posture III is described in more detail in Appendix A.

submarine-based systems. A similar degree of Soviet ingenuity and adaptiveness in penetration measures would also permit the Russians to race with U.S. defensive efforts on relatively favorable terms.*

With far less ability to reduce Soviet damage potential, the threat of a U.S.-initiated counterforce strike will lose credibility and deterrent value, perhaps altogether. To be sure, the existence of large forces of nuclear weapons will leave decisionmakers apprehensive about the possibility of unintended outbreak due to escalation from crises or limited wars; but the character of the process would be altered radically if it were impossible for either side to achieve a substantial military advantage by initiating an attack.

--The mere possibility that the Soviets might develop posture III is far from a sufficient reason for us to abandon efforts now to maintain a U.S. damage-limiting capability in general, or a counterforce capability in particular. The relative implausibility of the change in Soviet policy and programs implied by posture III has been discussed in Section II. In addition, although barge-based and very hard missile systems appear to be attractive possibilities to reduce force vulnerability, they are as yet paper systems. They have neither been built nor operated and it is not only possible but likely that if they are built, difficulties in detail will crop up with a serious effect on their vulnerability. Moreover, if they become operational, they will be subjected to close scrutiny by opposing target planners looking for weak points. In the case of systems depending upon concealment, like the barge-based systems, there might be intensive intelligence collection efforts to search for location giveaways. Enemy offensive systems may prove to be as resistant to such attention as missile carrying submarines have to date, but proximity in space or time has a way of revealing defects that are invisible from a distance.

Postures similar to posture III are neither sufficiently likely to materialize nor certain enough in their effects to warrant fatalism about the future of counterforce capability. Rather, they should stimulate attention to and invention of countermeasures in likely areas of Soviet developments.

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*A. Latter, Big Payloads Versus Ballistic Missile Defense (U), The RAND Corporation, RM-3556-PR, March 1963 (Secret-Restricted Data).

VI. CONCLUSIONS

THIS REPORT is insufficient in scope to provide a basis for deciding whether to try to preserve the kind of ability to reduce Soviet damage potential the U. S. has possessed in the recent past. Instead, it has been considered whether, and to what extent, it will be possible to preserve this capability, and what sorts of measures may be called for, given the decision to make the attempt. Both questions have been found to be quite sensitive to variations in Soviet posture that are sufficiently plausible to merit consideration.

Intelligence estimates of 1970 Soviet forces show a very substantial increase in their intercontinental offensive forces and their defensive capabilities. If the Soviet posture evolves conservatively, with relatively slow changes from past patterns, it could very well look like postures I or II and might appear even less formidable. Despite the increased Soviet emphasis on intercontinental offensive forces and the adoption of vulnerability reducing measures such as hardening and mobility, the United States will still be able to effect substantial reductions in Soviet damage potential against either the United States or its Allies by U. S.-initiated counterforce attacks. To reduce Soviet damage potential to levels at which U. S. first-strike threats will continue to have deterrent value, there will have to be combinations of measures including active and passive defense of civil targets and wartime deterrence of indiscriminate enemy attacks against civil targets, as well as counterforce. If the Soviets leave themselves particularly vulnerable to counterforce, the United States may be able to reduce its reliance on other measures. For example, if the Soviets were unable or unwilling to develop forces with high alert capabilities in times of tension, the counterforce task might be relatively straightforward and sufficient. But we cannot now predict with confidence even that there will be Soviet mistakes in 1970, let alone their specific character: and we ought not to rely upon them in planning our 1970 forces. Even without glaring mistakes, Soviet objectives and resource allocations may produce a posture against which a combination of U.S. measures, each of which has serious deficiencies taken alone, can offer a credible U.S. first-strike damage-limiting capability.

By acquiring appropriate combinations of capabilities, the expected outcomes can be improved in many contingencies relative to their present levels. However, the Soviet buildup will increase the risk of great U.S. damage if things do not go as planned. If a U.S.-initiated strike fails to achieve tactical surprise, the Soviets respond to warning before the impact of the U.S. missile wave, and coercion fails to induce them to make a discriminating response, the outcome can be much worse in the 1970 situation with the larger force of Soviet intercontinental weapons than is expected at present. To reduce this risk, the United States would need a large force of highly reliable antimissile systems. Together with the civil defense, which would be complementary to the active defenses, such a program is uncertain of accomplishment and would be very expensive. But other, more favorable contingencies are also relevant, and forces capable of performing well in them can provide both deterrent and insurance benefits.

Even if U.S. defenses can be saturated or bypassed by large enough Soviet attacks, they may still be very useful in dealing with the small Soviet forces that might survive our counterforce attacks. Defense programs with this objective need not be prohibitively large and expensive. Similarly, counterforce attacks are risky, and, against diversified retaliatory forces, unlikely to give high assurance of reducing Soviet damage potential far enough to be useful. By requiring any single element of our damage-limiting capabilities to do the whole job, we press that element so far that the payoffs to additional effort become insignificant. Combinations of measures, however, each with its own deficiencies, but each remedying some of the deficiencies of the others, can perform significantly better than forces that restrict themselves to one approach.

Although Soviet posture III may be considered relatively unlikely, it illustrates that we cannot rule out the possibility of a Soviet posture that will make attacks against their offensive weapons relatively pointless and sharply reduce the credibility of U.S. first-strike threats. Therefore the United States cannot commit itself now to maintaining a credible first-strike threat indefinitely. An unconditional commitment, however, is not required. Rather, the question is whether we should continue the efforts necessary to maintain a strategic superiority against Soviet postures similar to postures I and II.* Mere inertia will probably suffice to ensure the disappearance of a useful U.S. superiority. Its maintenance, on the other hand, is likely to require intense effort and a good deal of imagination. Brute force tactics, relying solely on ever increasing ICBM forces and ever larger warhead yields, are likely to be too expensive, inflexible, and undiscriminating for the next decade.

The size of our 1970 missile force need not be decided once and for all in 1963. Against a less formidable Soviet posture than posture I, the current OSD program might be adequate. Against the more dispersed, harder Soviet posture II, missile forces approaching the size of the USAF proposed posture might be more desirable in conjunction with an improved force of penetrating aircraft. But there ought to be better information about the likely 1970 Soviet postures well before that date. A better decision on the size of our missile force can then be made. At the very least, the United States ought to maintain superiority in the number of missiles on launcher to make sure that Soviet incentives for surprise attack or preemption are low. Beyond this our missile force ought to have the qualitative characteristics to permit flexibility of tactics. For example, if further consideration of devices like the thermonuclear land mine suggest that they are useful, we may want missiles with a large enough payload capability to carry several of them or to carry a normally fused warhead with one or more of the land mines. In general, qualitative changes in our forces, requiring new developments, have longer lead times than decisions on the force size. And to do the job entirely by programming large enough numbers of missiles might be a temptation against posture I; but it looks very unpromising against posture II. It has the defect of being much too dependent on enemy posture.

The continued pursuit of U.S. strategic superiority is not inevitably doomed to failure. This effort cannot restore a situation equivalent to the nuclear monopoly

*Some of the benefits and risks of following other strategic objectives that give up the attempt to maintain a significant asymmetry of capability vis à vis the Soviet Union have been considered elsewhere in the ACWS Project. See S. Wildhorn and H. Averch, Risk, Ambiguity and Force Structure: A Comparison of ACWS-SAFE Cases C and D (U), The RAND Corporation, RM-3511-PR, July 1963 (Secret).

we once enjoyed. but a lesser capability has seemed a stabilizing factor in recent crises. It may be that these crises could have been handled satisfactorily in the absence of U.S. strategic superiority: but we know of no evidence to prove this. The future would provide ample opportunity if we wished to experiment by discarding our superiority. The effects of such tests, if unfavorable, would not be easily reversible. And the experiment is not inevitable. Our analysis suggests that the United States can preserve a significant measure of superiority in a variety of likely future situations.

Appendix A

THREE POSSIBLE 1970 SOVIET POSTURES

THE BASES for the choice of the three Soviet postures to be considered in the analysis were discussed in Section II of the text and are analyzed in greater detail here. Each of the postures may be viewed as having followed a different path from the current Soviet strategic state -- depending on policies, budgets, and technology (not only of the Soviet Union but also of the United States). Each possibility is internally consistent in that it conforms to an explicit set of budgeting, programming, and development constraints. Some discussion of the relative plausibility of the postures will be given in the following section.

The three possibilities by no means span the gamut of credible alternatives. There is no image here of a vigorous Soviet opponent who takes the lead in an arms race; nor of one who is heavily oriented toward space systems for military as well as nonmilitary aims; nor of a Soviet leadership that reduces its intercontinental forces to near-austerity, that its military forces may be focused on retaining primacy in the Communist bloc. These omissions indicate, in part, what the three posture possibilities are not. Table A-1 suggests grossly what they are.

Postures I and II involve modest deviations from AFNIN estimates for the 1970 Soviet strategic forces.* Both of them maintain the rate of strategic spending at the 1963 level -- approximately $11 billion annually for the budget sectors included in the present discussion.

In posture I the Soviet force planners tend to maintain their traditional emphasis on active defense and to be sluggish in the development of new ICBM systems. Instead they favor improving the SS-7 system that is currently becoming operational. Posture II is similar but incorporates a shift in emphasis toward the SS-9 system, a hypothetical, Minuteman-like ICBM.

*As of approximately January 1963.

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Table A-1

THREE POSSIBILITIES FOR SOVIET STRATEGIC POSTURE

	I	II	III
General-war Budget	Constant at the 1963 level	Constant at the 1963 level	5 per cent annual growth
Force Composition	Resembles USAF estimates, except for greater emphasis on SS-7s and less on advanced nuclear submarines	Resembles USAF estimates, except for greater emphasis on SS-9s and less on advanced nuclear submarines	A design by system analysts
Planning for Retaliatory Force Survival	Nominal	Nominal	Serious

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In both postures I and II the Russians act as though they were conscious of the problem of assuring survival of their retaliatory forces, but not alarmed by it. Despite their public declarations about U.S. proclivity to initiate war against them, the Soviet planners proceed to develop postures I and II as if they privately believe that the United States is readily deterred from such action. In postures I and II, the Soviets are neither energetic nor imaginative in exploiting their technological potential for advanced survival measures.

The stretchout in advanced nuclear submarine procurement in postures I and II (relative to the AFNIN projection for the 1964-1970 period) might be acceptable to the Soviets if they believe that the United States would assuredly be deterred from initiating general war by the prospect of a few million deaths. Also it reflects the inadequacy of a constant level of strategic spending to fund the larger AFNIN-estimated submarine program together with the other posture developments to be mentioned below.

Posture III is intended to illustrate what might occur if the Russians were to become significantly more flexible in their strategic doctrine: less confined by bureaucratic factors; more serious in their planning for retaliatory force survival; and more imaginative in applying new technology to the latter end.

To begin a more detailed presentation of the composition of the three Soviet posture possibilities, Table A-2 indicates the evolution of postures I and II and compares the 1970 postures with an AFNIN 1970 projection. Posture I is distinguished by the previously cited emphasis on the SS-7 ICBM, which in its hard version might roughly resemble the U.S. Titan ICBM. (b)(1),(b)(3):42 USC [redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) [redacted]

Table A-2 also shows the shift of emphasis to the SS-9 system that characterizes posture II. The assumed SS-9 ICBM resembles a U.S. Minuteman -- it is, perhaps, slightly heavier and uses storable liquid propellants instead of a solid propellant motor. The SS-9 is a later missile system than the SS-7, reflecting some technological innovations, easier producibility, and greater dispersal and hardness.

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Table A-2

EVOLUTION OF SOVIET STRATEGIC POSTURES I AND II

		1966		1968		1970		1970
		I	II	I	II	I	II	AFNIN
Missiles								
SS-7	soft	220	220	220	220	220	220	225
SS-7	hard[a]	220	180	260	180	420	180	175
SS-8	soft	40	40	40	40	40	40	50
SS-9	hard	-	80	-	160	-	480	300
SLCM	E-class submarines[b]	126	126	144	144	144	144	144
SLBM	H-class submarines[c]	54	54	69	69	69	69	69
SLBM	advanced nuclear submarines[d]	18	18	72	72	108	108	150
SLBM	nonnuclear submarines[e]	98	98	98	98	98	98	98
	Totals	736	816	903	983	1099	1339	1216
Bombers								
BADGER		810	810	540	540	200	200	200
BISON		90	90	45	45	-	-	10
BEAR		90	90	45	45	-	-	-
BLINDER		180	180	225	225	225	225	225
Follow-on heavy bomber		45	45	90	90	120	120	120

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Table A-2 (cont.)

EVOLUTION OF SOVIET STRATEGIC POSTURES I AND II

	1966 I and II	1968 I and II	1970 I and II	1970 AFNIN
Antibomber defenses				
Manned interceptors				
Fresco, Farmer, Flashlight	875	-	-	-
Fitter, Fishpot	925	775	350	350
Firebar, Flipper, Fiddler	550	825	850	850
AW-1965	50	300	500	500
SA-2 batteries	1080	1100	1100	1100
SA-3 batteries	400	500	500	500
Antimissile defenses				
Nike-X-type batteries	0	10	15	NA
Civil defenses				
Special fallout shelter spaces (millions)	10	15	20	NA
Improvised fallout shelter spaces (millions)	30	40	50	NA

Notes:

[a]Does not include one reload missile at each launcher.
[b]Six cruise missiles per submarine.
[c]Three ballistic missiles per submarine.
[d]Six ballistic missiles per submarine.
[e]Two or three missiles per submarine.

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In postures I and II no significant departures are made from the AFNIN projection for the SS-8 ICBM, purported to be the missile delivery system, if one exists, for the [redacted] warhead. *These missiles are believed to have* been operational in 1964, the beginning date for our posture projection. The assumed planning inertia leaves Soviet planners in postures I and II unable *either to increase or to retire the SS-8 force* by 1970.

Table A-2 also displays the extent of the stretchout in advanced nuclear submarine procurement present in postures I and II. The Soviet planners have shown their conservatism by building up their force of the less advanced H-class nuclear submarine (carrying three ballistic missiles) and the E-class nuclear submarine (purported to contain six cruise missiles), even though the more sophisticated (but more expensive) advanced nuclear submarine option is available during the 1964-1970 period.

Table A-2 compares the remaining major systems in the strategic forces of postures I and II over a six year period. The BEAR and BISON strategic bombers have completed their phase-out before 1970. The relatively few remaining BADGERS, which are on the brink of complete retirement, cannot be regarded as a substantial intercontinental threat to the United States. Postures I and II, as well as the AFNIN projection, contain a moderate quantity of a new heavy bomber that may become operational in 1964-1965. The characteristics of this aircraft are puzzling. To sacrifice essential range and payload to achieve a limited supersonic dash capability does not seem a prudent choice for Soviet designers.* For this report we impute performance characteristics to the follow-on heavy bomber that approximate those of the B-52G. Also we credit the Soviets (and adjust bomber system costs appropriately) with having provided a complex of, say, 75 dispersal fields.** This is in contrast with their current practice of concentrating their heavy bombers on a handful of airbases.

The antibomber defense arrangements of postures I and II generally mirror the AFNIN estimates. One distinction between postures I and II that is not revealed by Table A-2 is in the deployment of the SA-3 low-altitude defense batteries, only a small fraction of which have yet appeared in the Soviet Union. For

*This uncertainty reflects our lack of understanding of the motivation and future of the BOUNDER development program.

**In our targeting, we cover a large number of bomber capable fields. (See Appendix B.)

posture I the SA-3s are deployed in a 25-75 per cent split between the local defense of urban areas and of military installations (principally ICBM sites); for posture II, they are split evenly between the two types of targets.* This greater emphasis on the security of retaliatory forces is consistent with the shift to the SS-9 in this posture.

Table A-2 omits the 1970 AFNIN estimate for antimissile defense since it would not be comparable with postures I and II, in which the Soviet defense program changes direction and follows the U.S. lead into Nike-X-type systems. Thus, instead of a "poor man's" Nike Zeus (the current intelligence view of the early Soviet antimissile defenses) postures I and II incorporate a system with a high-acceleration interceptor missile like the U.S. Sprint design -- delayed commitment to facilitate atmospheric filtering of decoys, and hardened, phased-array radars to deter defense busting tactics. The cost of the 15 battery antimissile defense program (including research, development, and testing) would approximate $6 billion; an appropriate deployment would be for the defense of the 6 largest cities.

Finally, in the matter of the civil defense program, postures I and II provide high quality sheltering to an additional one-third of the Soviet population, with the urbanites getting most of the protection. Part of the six-year program is a $2 or $3 billion outlay for building underground fallout shelters. With some care in design, these shelters (at a cost of $100-$150 per space) could afford a moderate degree of blast protection -- say, against 15 psi overpressure effects. Most of the shelters, however, are of the improvised type, with space in existing buildings being established and provisioned at a cost of $25-$30 per person.

The main elements of posture III are indicated in Table A-3 as they evolve over a six-year period. This Soviet posture is based on a budget that grows at 5 per cent per year -- approximately the rate of GNP growth now being attributed to the Soviet economy. The strategic budget growth produces roughly an additional $15 billion for the Soviet planners to work with in the 1964-1970 period. This extra money does make some differences in force structure -- for example.

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*The deployment pattern of SA-2 and ICBM sites observed to date suggest that there has been a smaller allocation of SAMs to the defense of offensive missiles per se, but that the missiles have been sited to derive some coverage from SAMs at other targets.

Table A-3

EVOLUTION OF SOVIET STRATEGIC POSTURE III

		1966	1968	1970
Missiles				
SS-7	soft	220	-	-
SS-7	hard[a]	140	-	-
SS-8	soft	40	-	-
SS-9	hard	160	160	-
SS-9	superhard	100	230	400
SS-9	barge based	100	260	400
Heavy-payload ICBM barge based or in superhard silos		-	40	80
SLCM	E-class submarines[b]	108	126	126
SLBM	H-class submarines[c]	63	72	72
SLBM	Advanced nuclear submarines[d]	36	108	198
SLBM	Nonnuclear submarines[e]	98	98	98
	Totals	1065	1094	1374
Bombers				
BADGER		630	405	180
BISON		90	90	-
BEAR		90	45	-
BLINDER		90	90	90
Multiple-purpose, long-endurance aircraft		-	45	90

Table A-3 (cont.)

EVOLUTION OF SOVIET STRATEGIC POSTURE III

	1966	1968	1970
Antibomber defenses			
Manned interceptors	225	-	-
Multiple-purpose, long-endurance aircraft carrying Eagle missiles	-	90	225
SA-2 batteries	990	990	990
SA-3 batteries	498	498	498
Antimissile defenses			
Nike-X-type batteries	-	10	35
Civil defenses			
Special fallout shelter spaces (millions)	15	38	45
Improvised fallout shelter spaces (millions)	15	28	60

Notes:

[a] Does not include one reload missile at each launcher.

[b] Six cruise missiles per submarine.

[c] Three ballistic missiles per submarine.

[d] Six ballistic missiles per submarine.

[e] Two or three missiles per submarine.

in the extent of antimissile defense deployment -- but these differences are secondary compared with those that result from the increased vigor and inventiveness of Soviet planning actions in posture III.

If Table A-3 is compared with Table A-2, we observe that the number of missiles that threaten the United States in 1970 has increased only moderately. In posture III the total is about 1350; in posture I it is 1100; in posture II, approximately 1350; and the AFNIN projection has a rough total of 1200. Thus, among the four possibilities, there is a disparity of less than 25 per cent. Qualitatively, however, posture III is distinctive: in 1970 there are 800 Minuteman-like SS-9s, split evenly between two forms of basing that accentuate survivability, missile launching, submersible barges, and superhard silos.

The submersible barges are usually hidden from view, mobile, and resistant to overpressures of several hundred psi. The particular design embodied in posture III contains 10 missiles per barge and may operate in the Caspian Sea, the Sea of Aral, or Lake Baikal. Although submersible barge basing promises an extraordinary degree of resistance to counterforce attacks, prudence might induce the Russians to insure their retaliatory capability by acquiring variety. Therefore one-half of the SS-9 force of posture III is housed in second generation silos of 1000 psi or greater design hardness. No such silos have been constructed, let alone tested, but at the present they seem to be within reach by 1970.

Table A-3 shows that the SS-8, the first generation, large payload vehicle, has been phased out in favor of a more advanced system. The new ICBM not only carries upwards of 20,000 pounds of payload, as did the earlier SS-8, but lends itself to survivability measures, which the SS-8 did not.

Instead of the 18 advanced nuclear submarines of postures I and II, posture III contains 31 in 1970. The number of H-class, E-class, Z-class, and G-class submarines remains unchanged.

Posture III includes a multiple-purpose, long-endurance aircraft (MPLE) which replaces the more prosaic follow-on heavy bomber of the other postures. The specific MPLE design is a 500,000-pound aircraft that has a 100,000-pound payload and a three-day endurance. Its design is aimed at minimizing the cost of maintaining a large scale (at least one-third) airborne alert. In a period of crisis, the airborne alert fraction might be as high as two-thirds. Posture III also assumes the development of several advanced weapons to be carried by offensive MPLE aircraft: a highly accurate standoff aerodynamic missile similar to the (U.S.) proposed CLAM design; a short range terminal missile similar to the (U.S.) proposed Wagtail design: and and air-to-air missile resembling the Bendix Eagle design, particularly for the purpose of countering active defenses.

The Soviet planners also use MPLE aircraft. equipped with 30 or more Eagle-like missiles, as a survivable antibomber area defense system. The conventional Soviet air defense interceptors are phased down steadily in posture III until their final phase-out in 1969.

The SA-2 and SA-3 forces finish their buildup early in the 1964-1970 period and require operating charges totaling less than $1 billion per year: furthermore, their inherently dispersed nature leaves them less vulnerable to attack than area defenses. It is natural. therefore, to retain them in posture III to preserve variety in antibomber defenses.

As Table A-3 indicates, the larger budgets available in posture III permit a more generous deployment of antimissile defense batteries to be made. These 35 batteries can be sited at a dozen or more of the largest cities. The program costs about $10 billion.

A final major element of posture III is civil defense, which is extended to an additional one-half of the population. The six-year program results in specially built fallout shelters for most of the residents of the larger cities (populations of several hundred thousands or greater).

If the Soviets embark on force changes as substantial as those exemplified by posture III, they will alter some past spending practices quite radically. Roughly equal budget shares are allocated to offense and defense in all three postures, a modest shift in favor of offense by comparison with previous years. The important spending shifts in posture III are toward a greater strategic missile emphasis within the offense sector, and toward greater attention to antimissile defense and civil defense at the relative expense of antibomber defense within the defense sector. Figure A-1 displays this change of spending pattern. (The totals include allowances for R&D, command and control, warning, warheads, and so on.)

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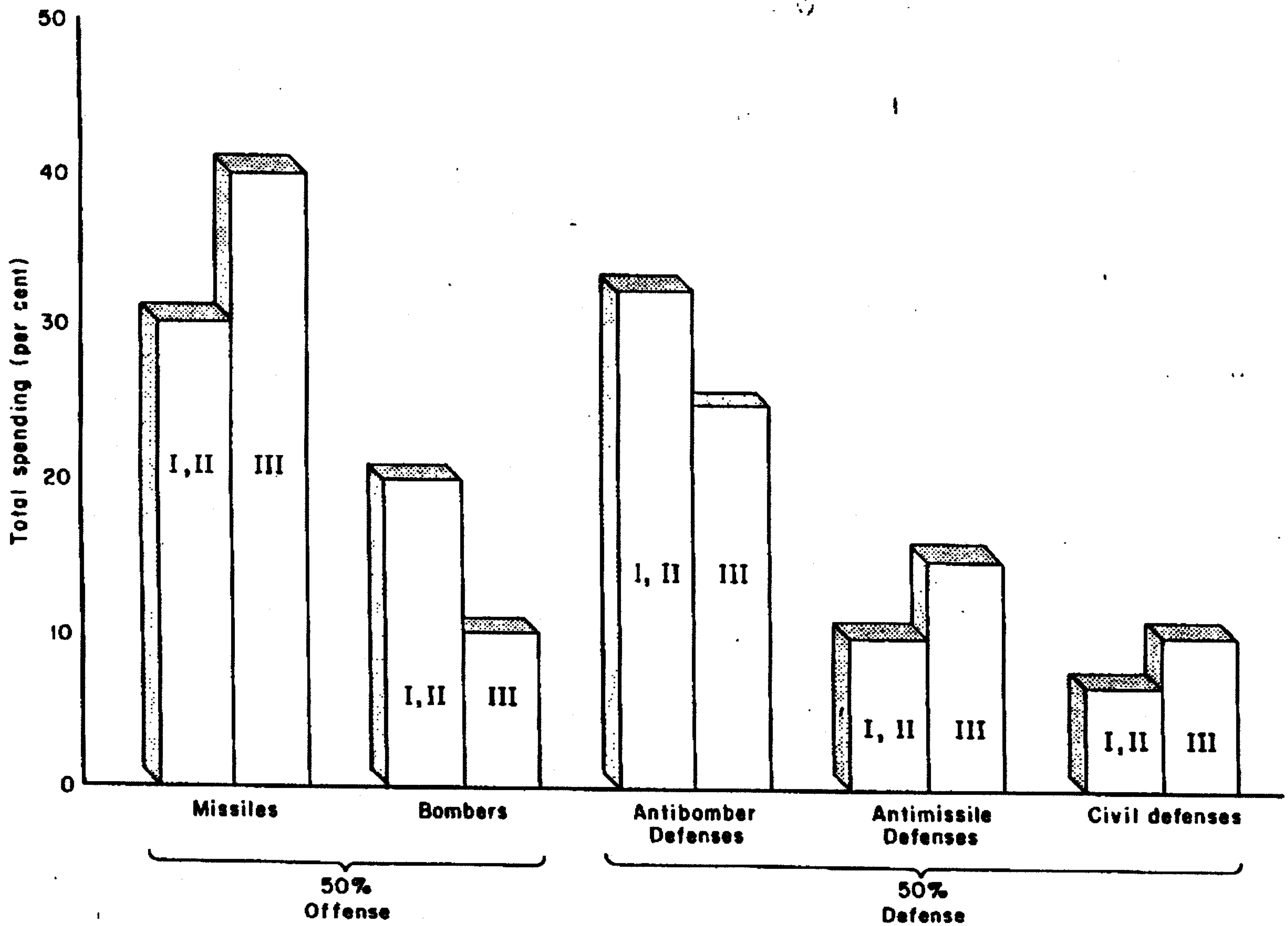

Fig. A-1 — Spending patterns for the three possible Soviet postures, 1964-1970

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Another way of revealing the reorientation of budgets implied by posture III is to compare its ratio of investment spending to operating charges with that of postures I and II. The former is 2/1, the latter is 1/1.

Such dramatic shifts of Soviet spending ought to be relatively visible to the U.S. intelligence community soon after they gain momentum. On the other hand, we cannot confidently expect to discern the changes in strategic doctrine that motivate new directions of spending.

Appendix B

U. S.-INITIATED COUNTERFORCE STRIKES AGAINST NONREACTING SOVIET POSTURES I AND II

THIS APPENDIX provides the data and methodology used in designing and evaluating U. S.-initiated counterforce strikes against the nonreacting Soviets. Soviet postures I and II are both considered. First, alternative Soviet target systems are displayed. The feasibility of counterforce against the Soviet land-based targets with the missile forces in the OSD and USAF projected postures and in the so-called improved posture is discussed next. Finally, the follow-on bomber strikes against hard targets are shown, including some discussion of the rudimentary local defense model employed.

TARGET SYSTEMS FOR U. S. STRIKES

Table B-1 displays the 1970 Soviet missile target systems. Postures I and II are shown, and both soft and hard missiles are included. The number of missiles per site (aim point) is based on an AFNIN estimate. We are unaware of firm estimates on the hardness of Soviet hard missiles: our assumption is that the SS-7 and the SS-5 are somewhat harder than VN = 34P6. The SS-9 is treated as VN = 43P6; and the soft SS-4, 7, and 8 are VN = 13Q9.*

Table B-2 shows the nonmissile targets considered. These are AFNIN estimates of current targets and are assumed to illustrative of the 1970 situation. A high case and a low case, differing only in the number of offensive and defensive airfields, are considered with Soviet posture I and correspond to those shown on Fig. 2. In the high cases, (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) [redacted]

*AFM 200-8 defines the VN system of vulnerability rating.

Table B-1

THE SU MISSILES AS TARGET SYSTEMS -- 1970

	Posture I		Posture II	
	No. Aim Points	No. Missiles on Launchers	No. Aim Points	No. Missiles on Launchers
Soft (VN = 13Q9)				
SS-4 (4 aim pt.)	75	300	75	300
SS-7 (2 aim pt.)	110	220	110	220
SS-8 (2 aim pt.)	20	40	20	40
Total Soft	205	560	205	560
Hard (VN ≡ 34P6)				
SS-5 (2 aim pt.)	75	150	75	150
SS-7 (2 aim pt.)[a]	210	420	90	180
Fully Hard (VN = 43P6)				
SS-9 (1 aim pt.)	-	-	480	480
Total Hard	285	570	645	810

Note:

[a]Does not include one additional reload missile per launcher.

[redacted] in the Soviet Union and satellites are targeted. Roughly 80 per cent of all the [redacted] in the Soviet Union and satellites are targeted in this case. Only 100 [redacted] are specified in the low case. A medium case is considered with posture II, differing from the high case only in the number of [redacted] are targeted.

Table B-2

NUMBERS OF SOVIET NONMISSILE TARGET SYSTEMS

		Posture		
Case	VN	I High	I Low	II Medium

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[redacted]

Notes:

[redacted]

[b]Primary.

Table B-3 shows the capabilities of the U. S. weapon systems against soft and hard missile targets. The single-shot kill probability values displayed do not include effects of reliability. The hard missile target is alternatively viewed as a (b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD) [redacted] arget, as indicated in the text. Note that no distinction is made

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

DOE (b)(3)

between Wing I Minuteman and Wings II-V Minuteman capabilities. [redacted] Since all Wing I-V Minuteman are [redacted] differences in CEP and yield would not significantly alter the damage probability to these targets.

MISSILE STRIKES

Table B-4 shows the calculations supporting the results displayed in Fig. 1. Little needs to be added to the discussion in Section III of the text of this report except that a continuous uniform assignment model was used in calculating the number of surviving hard missiles. This is also the case for soft missiles.

Table B-4

OSD MISSILE FORCE VERSUS SU POSTURE I HARD MISSILES[a]

Missile Type	No. of Missiles Assigned	No. Missiles Assigned per Aim Point	$1-RP_K$	Fraction Aim Points Surviving (cumulative)	No. SU Missiles on Launchers Surviving (cumulative)
Titan II	[redacted]				
Minuteman C					
Atlas-Titan I					
Polaris (on station)					
Minuteman A/B					

Note:

[a] [redacted]

Table B-5 shows these calculations: they are also plotted in Fig. 1. Note that the order of assignment is reversed. Those missiles in the U.S. force with poorer yield-CEP-reliability combinations are allocated to the [redacted] first, and the better ones are reserved for [redacted] Addition of the surviving [redacted] results in the U-shaped curve of Fig. 1. Withdrawing some U.S. missiles for the tasks of attacking [redacted] as shown in Fig. 2.

Table B-5

OSD MISSILE FORCE VERSUS SU POSTURE I SOFT MISSILES[a]

Missile Type	No. of Missiles Assigned	No. Missiles Assigned per Aim Point	$1-RP_K$	Fraction Aim Points Surviving (cumulative)	No. SU Missiles on Launchers Surviving (cumulative)
Minuteman A, B	[redacted]				
Minuteman A, B					
Polaris (on station)					
Atlas-Titan I					
Minuteman C					
Titan II					

Note:

a [redacted]

Tables B-6 through B-11 show the detailed allocation of the missile strikes and the resulting survivors for those cases discussed in Section III and IV of the text. The allocations correspond to the minimum points on the U-shaped curve referred to above. They include the high and low target lists in the OSD force versus Soviet posture I case. All hard missiles in Soviet posture I are treated as 300 psi. A medium target list is considered for the USAF force versus Soviet posture II case, and the SS-9 missiles are treated as 1350 psi hard. Finally, the improved U.S. force versus Soviet posture II with a medium target list is considered; SS-9s are assumed to be 1350 psi hard. Reliability monitoring of U.S. missile launches is assumed operational.

In attacking soft nonmissile targets the targeting policy followed was to assign two missiles per aim point to account for reliability. In the improved U.S. force case, with a reliability monitoring capability, only one reliable missile per aim point was assigned. On the average, then, with reliability monitoring, the missile force size required to hit N soft targets is equal to N/R, where R is the over-all reliability.

Against soft missile targets, where possible, at least two missiles were assigned per aim point. In cases where missiles were relatively plentiful compared with targets, assignments in excess of two missiles per soft aim point were made on a marginal kill basis in competition with the marginal kill capability versus hard missile targets. The objective was minimizing the total number of surviving Soviet missiles, both hard and soft. Against hard missile targets, at least one missile per aim point was assigned and, where available, two or more were allocated. In the case where SS-7s were treated as [redacted] hard and SS-9s as [redacted] [redacted] (Table B-10), optimal allocation dictated [redacted] per 300 psi point and [redacted] [redacted] per [redacted] point, taking into account the deployment configuration; that is [redacted] per aim point compared with [redacted] per aim point.

Table B-6

ALLOCATION OF PROGRAMMED U.S. MISSILE FORCE TO SU POSTURE I
("high" target list; [redacted] hard missiles)

Target Class	Number of Aim Points	Weapon Class	Total Number Assigned[a]	Weapons per Aim Point	Reli-ability	Single Shot P_K versus Missiles	1-RP_K versus Missiles	Number Aim Points Surviving	Number Missiles on Launchers Surviving
[redacted]									

(b)(1),(b)(3) 42 USC §2168(a)(1)(C) (FRD)

Note:

[redacted]

(b)(1),(b)(3) 42 USC §2168(a)(1)(C) (FRD)

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Table B-7

ALLOCATION OF PROGRAMMED U.S. MISSILE FORCE TO SU POSTURE I
("low" target list; [redacted] hard missiles)

Target Class	Number of Aim Points	Weapon Class	Total Number Assigned[a]	Weapons per Aim Point	1-RP_k versus Missiles	Number Aim Points Surviving	Number Missiles on Launchers Surviving
[redacted]							

(b)(1),(b)(3) 42 USC §2168(a)(1)(C)-(FRD)

Note: [redacted]

(b)(1),(b)(3) 42 USC §2168(a)(1)(C)-(FRD)

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Table B-8

ALLOCATION OF USAF PROPOSED MISSILE FORCE TO SU POSTURE I
("high" target list; [redacted] hard missiles)

Target Class	Number of Aim Points	Weapon Class	Total Number Assigned[a]	Weapons per Aim Point	1-RP$_k$ versus Missiles	Number Aim Points Surviving	Number Missiles on Launchers Surviving
[redacted]							

(b)(1),(b)(3) 42 USC §2168(a)(1)(C)-(FRD)

Note:

[redacted]

Table B-9

ALLOCATION OF USAF PROPOSED MISSILE FORCE TO SU POSTURE I
("low" target list, [redacted] hard missiles)

Target Class	Number of Aim Points	Weapon Class	Total Number Assigned[a]	Weapons per Aim Point	1-RP_k versus Missiles	Number Aim Points Surviving	Number Missiles on Launchers Surviving
[redacted]							

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

Note:

[redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

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Table B-10

ALLOCATION OF USAF PROPOSED MISSILE FORCE TO SU POSTURE II
("medium" target list; [redacted] hard SS-9)

Target Class	Number of Aim Points	Weapon Class	Total Number Assigned[a]	Weapons per Aim Point	1-RP_k versus Missiles	Number Aim Points Surviving	Number Missiles on Launchers Surviving
[redacted]							

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

Note:

[redacted]

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Table B-11

ALLOCATION OF IMPROVED U.S. MISSILE FORCE TO SU POSTURE II

("medium" target list; [redacted] reliability monitoring)

Target Class	No. of Aim Points	Weapon Class	Total Number Assigned[a]	Weapons per Aim Point	Reliability	$1-RP_k$	No. Aim Points Surviving	No. Missiles on Launchers Surviving
[redacted]								

Notes:

[redacted]

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In improved U.S. force versus Soviet posture II. the missile force requirement was derived on the following basis: On the assumption that separate boosters are needed to deliver a thermonuclear land mine and a conventional nuclear warhead. one reliable Minuteman C mine per missile launcher and one reliable Minuteman C warhead per aim point were assigned against the hard missile sites. A separate mine is required per [redacted] rather than [redacted] As before, one reliable warhead was allocated to each of the [redacted] where more Minutemen A and B were used to improve the damage probability. This allocation led to a force requirement of about [redacted] in excess of the USAF projected force. However, if further study indicates the feasibility of a single Minuteman C booster to carry both a mine and a (smaller) nuclear warhead, force size would be reduced. Or, if this turns out to be infeasible for the Minuteman, we might want missiles with the payload capability large enough to do so.

Against the [redacted] two missiles (or one reliable missile) were assigned [redacted] In all cases involving the OSD programmed or USAF projected forces, a reserve force of [redacted] withheld. Some [redacted] were withheld in the improved U.S. force case. but this difference is a result of minor alterations in allocation and should not be considered significant.

FOLLOW-ON LOW ALTITUDE B-52 STRIKES AGAINST HARD MISSILE TARGETS

Since the B-52 strikes follow the initial U.S. ICBM attack, we have assumed that the missile attack has degraded Soviet zonal (fighter) defenses to the point where only the local SAM defenses are a threat to the incoming bombers. The penetration models and optimal allocation of bombs to each target type (hardness) are discussed and subsequently applied to the relevant cases. We will show, as a function of number of B-52s assigned. the surviving hard missiles in SU posture I when attacked by the programmed and the USAF proposed forces; SU posture II versus the USAF proposed force, with and without shoot-look-shoot capabilities; and finally, SU posture II versus the improved U.S. force using short range ASM with shoot-look-shoot tactics.

PENETRATION MODEL -- SOVIET POSTURE I

The general sequence of events in a bomber penetration is visualized as follows. The B-52 fires its GAM-77s (Hound Dog) against the [redacted] It then attempts to penetrate these degraded defenses at low altitude and drop a single lay down weapon at each of n targets in succession, where n is the number of bombs carried per aircraft. A pair of [redacted] are assumed deployed together. The geometric [redacted]

We are aware that clustering [redacted] Because the calculations to follow are only illustrative and, more importantly, because the major points made in the text of this report are not sensitive to the penetration model employed, we have chosen to use a model that is computationally simple.

The probability that a missile site survives the attack is:

$$\Big[1 - P\,\{\text{Bomber is reliable and reaches defended area}\} \times P\,\{\text{a bomb is successfully dropped}\} \times P\,\{\text{a single bomb will kill the target}\}\Big]^{b}$$

The probability that an assigned bomb is successfully dropped is viewed as the average fraction of assigned bombs successfully delivered through the defenses. This assumption implies that on the average, every target will receive as many early bomber visits as any other target. Also, every target will receive as many late bomber visits as any other target.

Let:

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

N_B = [redacted]

n = [redacted]

b = [redacted]

N_T = [redacted]

R_B = [redacted]

R_{HD} = [redacted]

N_{HD} = [redacted]

N_{SAM} = [redacted]

KP_{HD} = [redacted]

KP_B = [redacted]

p_{HD} = [redacted]

$P_{K_{HD}}$ = [redacted]

p = [redacted]

p_K = [redacted]

n_E = [redacted]

$n_E\ n$ = [redacted]

s = [redacted]

---

*See O. Helmer and T. A. Brown, *SAFE: A Strategy-and-Force Evaluation Game* (U), The RAND Corporation, RM-3287-PR, October 1962 (Secret), for a tabulation of assumed SA-2 and SA-3 kill potential versus various threats.

With [redacted] B-52 aircraft and [redacted] GAM-77s programmed for 1970, and assuming that the number of GAM-77s launched is proportional to the number of B-52s launched, N_{HD} is expressed by

$$N_{HD} = \text{[redacted]}\ N_B = \text{[redacted]}\ N_B \qquad (1)$$

The probability that a Hound Dog successfully penetrates the SAM defenses is

$$p_{HD} = R_B\, R_{HD}\, e^{\text{[redacted]}} \qquad (2)$$

The number of SAM battery pairs surviving a uniformly assigned Hound Dog attack is

$$\text{[redacted]} = N_{SAM} \left(1 - p_{HD}\, p_{K_{HD}}\right)^{\text{[redacted]}} \qquad (3)$$

Substituting for N_{HD} and p_{HD} from Eqs. (1) and (2 [redacted] becomes

$$\text{[redacted]} \left[1 - R_B R_{HD} e^{\text{[redacted]}}\right]^{\text{[redacted]}}$$

$$\text{[redacted]} \left[1 - .72\ e^{\text{[redacted]}}\right]^{\text{[redacted]}} \qquad (4)$$

The surviving SAM kill potential per target versus the B-52.

[redacted] (5)

and the probability a B-52 survives each target visit through these degraded SAM defenses becomes

$p = e$ (b)(1),(b)(3):42 USC §2168 (a)(1)(C)--(FRD)

$= \exp - \Big[.3 \Big\{ 1 - .72\, e$ (b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD) (6)

A precise formulation for the bomber kill potential against the hard targets is mathematically difficult to compute. We have chosen an approximation employing the <u>average</u> number of bombs successfully dropped.* If p is the probability that a bomber survives a target visit, the probability that it survives exactly i visits is the probability that the bomber survives i visits in succession and is kill on the $(i+1)^{th}$: or

$$P\left\{n = i\right\} \equiv p_i = p^i(1-p) \tag{7}$$

The <u>expected</u> number of bombs dropped (successful target visits) is

$$n_E = \sum_{i=o}^{n} ip_i \tag{8}$$

Substitute for p_i.

$$n_E = \sum_{i=o}^{n-1} ip^i(1-p) + np^n \tag{9}$$

*Assuming that each target gets the same mixture of bombs by their order of delivery.

But, it can be shown that*

$$\sum_{i=o}^{n-1} ip^i = \frac{p(1-p^{n-1})}{(1-p)^2} - \frac{(n-1)p^n}{(1-p)} \qquad (10)$$

Substituting,

$$n_E = \frac{p(1-p^{n-1})}{1-p} - (n-1)p^n + np^n = \frac{p}{1-p}(1-p^n) \qquad (11)$$

Figure B-1 shows how the average number of bombs successfully delivered varies as the number loaded on each bomber varies, for several values of the penetration probability per target visited. It shows how quickly the advantages of multiple weapon loading are lost as attrition increases. Thus, the number of hard missile targets surviving the B-52 attack, $(N_T)_S$, as a function of N_B, is expressed by

$$(N_T)_S = sN_T(1-R_B \frac{n_E}{n} P_K)^b \qquad (12)$$

where

$b = nN_B / N_T$.

n_E in terms of p from Equation 11

p in terms of N_B and [redacted] from Equation 6

In Soviet posture I, N_T = [redacted] = 250, [redacted] p_K versus [redacted] target for a [redacted] CEP = [redacted] and p_K versus [redacted] target for a [redacted] CEP = [redacted]

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*L. B. W. Jolley, Summation of Series, Dover Publications, Inc. (Second Rev. Ed.), New York, 1961. See Series No. 5.

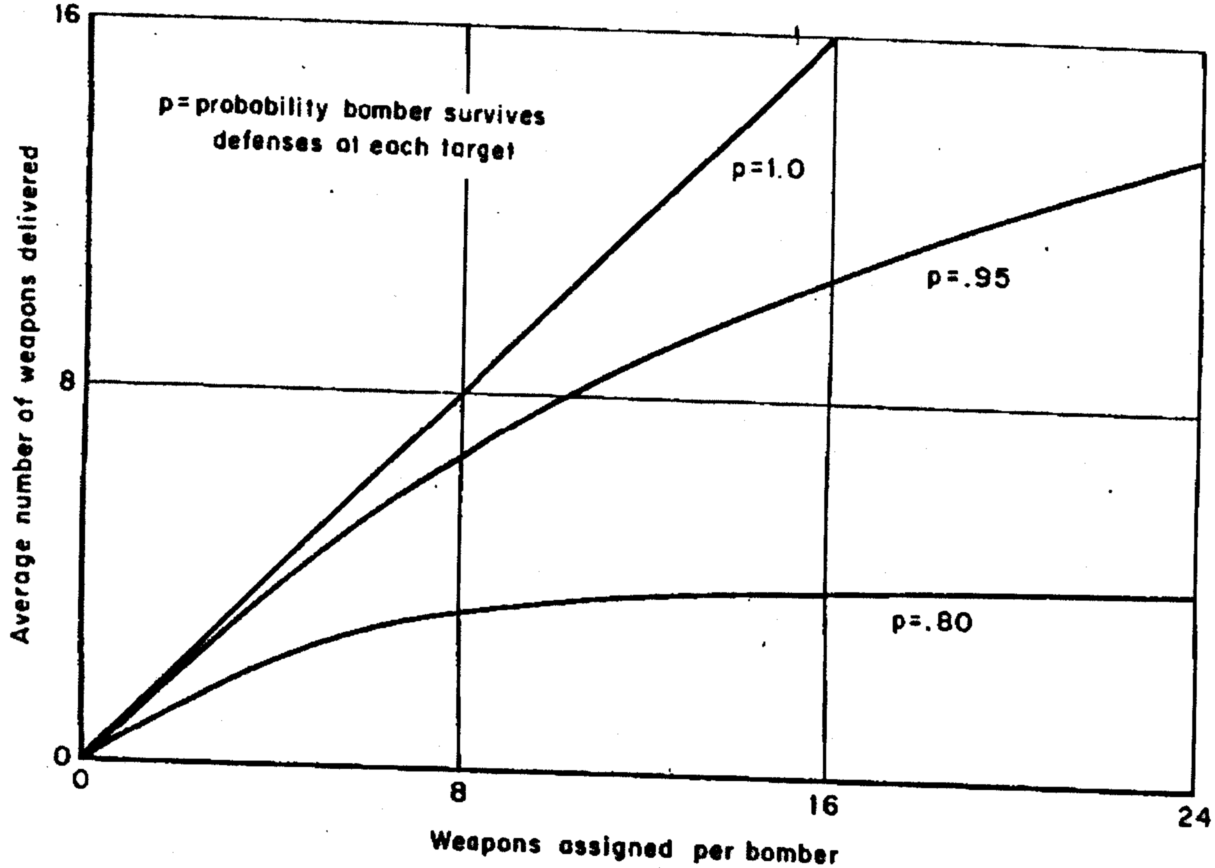

Fig. B-1 — Multiple weapon delivery and bombers attrition

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s is taken from Table 6 or 8, depending on the case. The model developed above simulates uniform targeting of bombs over all the (uniformly) hard targets.

PENETRATION AND ALLOCATION MODELS -- SOVIET POSTURE II

In Soviet posture II we assume that all the missiles are not uniformly hard. The SS-9s are viewed as [redacted] hard and the others -- SS-5s and SS-7s -- are [redacted] hard. We can write a modified target survival expression and determine the optimal allocation of bombs per target to each target hardness class. We will first treat the case in which no bomb damage information is available and then discuss the case in which miss distance information is available so that shoot-look-shoot tactics can be employed.

Uniform Assignment -- No Bomb Damage Information

If we denote the [redacted] target classes by subscripts 1 and 2 respectively, and if we require that the sum of the surviving [redacted] missiles be a minimum, Equation (12) becomes

$$v_1 s_1 N_{T_1} \left(1 - R_B \frac{n_E}{n} p_{K_1}\right)^{b_1} + v_2 s_2 N_{T_2} \left(1 - R_B \frac{n_E}{n} p_{K_2}\right)^{b_2} \qquad (13)$$

$$= \text{a minimum}$$

subject to the constraint that the bombs allocated to each target class sum to the total number of bombs in the assigned B-52 force, or

$$N_{T_1} b_1 + N_{T_2} b_2 = nN_B \qquad (14)$$

Note that in Equation 13 a v_i has been inserted. This quantity may be interpreted as the relative value of each target class. In physical terms, the analog is the number of missile launchers per target site if one views each missile type as equally valuable or equally dangerous; in the case of the SS-7 and SS-5 [redacted] v_2 would be [redacted] and for the SS-9 [redacted] v_i would be [redacted]

(b)(1),(b)(3):42 USC §2168(a) (1)(C)--(FRD)

[redacted]

Shoot-Look-Shoot Tactics Using Miss Distance Information

In this case we wish to determine the value of shoot-look-shoot (S-L-S) tactics using miss distance information. It is intuitively clear, at any rate, that S-L-S, using perfect miss distance information, has both a cost and a payoff in a defended environment. The value (or payoff) is, of course, related to the more efficient use of a given number of bombs. When a bomber penetrates to a target, looks and notices that the target is dead (with 100 per cent probability), that bomb can be used on the next successful penetration to a target that may be alive (with 100 per cent probability). The cost is related to the increased bomber attrition since, on the average, a bomber carrying n bombs attempts more than n successive penetrations.

To anticipate, the value of S-L-S tactics for the case of interest in this report turns out to be negligible. Consequently, we have employed a target survival model that provides an upper bound on the value of S-L-S tactics. Also, the model is much simpler computationally.

If we imagine that each bomber can carry a very large number of bombs and further, that the bomber has unlimited range so it can attempt a large number of penetrations (target visits) n_E becomes

$$\lim_{n\to\infty} (n_E) = \lim_{n\to\infty} \left[\frac{p}{1-p}(1-p^n)\right]$$

$$= \frac{p}{1-p} \equiv n_E^* \qquad (19)$$

The probability that a hard missile target survives can be rewritten as

$$\left(1 - R_B p_K \frac{n_E^*}{n}\right)^{\frac{nN_B}{N_T}} = \left[\left(1 - \frac{K}{n}\right)^{n/K}\right]^{\frac{KN_B}{N_T}} \qquad (20)$$

where

$$K = R_B \, n_E^* \, p_K$$

Since

$$\lim_{x \to o} (1+x)^{-\frac{1}{x}} = \frac{1}{e} \tag{21}$$

and if

$$x = K \cdot n$$

then

$$\lim_{n \to \infty} \left[(1 - \frac{K}{n})^{n \; K} \right]^{\frac{KN_B}{N_T}} = e^{-\frac{KN_B}{N_T}} = e^{-R_B n_E^* p_K \frac{N_B}{N_T}} \tag{22}$$

Writing the minimization equation for the number of targets surviving in the above form. Equation 13 becomes.

$$v_1 s_1 N_{T_1} \left[e^{-R_B \, n_E^* \, p_{K_1} \frac{N_{B_1}}{N_{T_1}}} \right] + v_2 s_2 N_{T_2} \left[e^{-R_B \, n_E^* \, p_{K_2} \frac{N_{B_2}}{N_{T_2}}} \right]$$

$$= \text{a minimum} \tag{23}$$

subject to the constraint that the bombers allocated to each target class sum to the total N_B, or.

$$N_{B_1} + N_{B_2} = N_B \tag{24}$$

Solving Equation 24 for N_{B_1}, substituting in Equation 23 and differentiating with respect to N_{B_2}, we find that,[1]

$$v_1 s_1 N_{T_1} \left[e^{-\frac{R_B n_E^* p_{K_1} N_B}{N_{T_1}}} \right] \left[\frac{R_B n_E^* p_{K_1}}{N_{T_1}} \right] \left[e^{\frac{R_B n_E^* p_{K_1} N_{B_2}}{N_{T_2}}} \right]$$

$$- v_2 s_2 N_{T_2} \left[\frac{R_B n_E^* p_{K_2}}{N_{T_2}} \right] \left[e^{-\frac{R_B n_E^* N_{B_2}}{N_{T_2}}} \right] = 0 \qquad (25)$$

Collecting terms and solving for N_{B_2}, the optimal allocation of bombers to each of the target classes is

$$N_{B_2} = \frac{1}{R_B n_E^* \left(\frac{p_{K_1}}{N_{T_1}} + \frac{p_{K_2}}{N_{T_2}} \right)} \left[\ln \left(\frac{v_2 s_2 p_{K_2}}{v_1 s_1 p_{K_1}} \right) + \frac{R_B n_E^* N_B}{N_{T_1}} \right] \qquad (26)$$

$$N_{B_1} = N_B - N_{B_2} \qquad (27)$$

where

n_E^* in terms of p from Equation 19,

p in terms of N_B and N_{SAM} from Equation 6.

In Soviet posture II, N_{T_1} = [redacted] = 2, v_2 = 1, and for a [redacted] $p_{K_1} = p_{K_2}$ = [redacted] and s_2 are taken from Table B-10.

The models derived above apply only to B-52 attacks using gravity lay-down weapons in which penetration of the defense must be attempted in order to attack the target. The last case we consider is that of the improved U.S. versus Soviet posture II, in which the B-52s are equipped with a strike-recce package of 16 short-range ASM and a side looking radar installation. We have assumed that with the strike-recce package the bombers are able to avoid the SAM defenses completely by attacking the missile sites from beyond their range. It turns out that this assumption does not prove critical since the results below show that a force of only 165 bombers is required to reduce the hard target system to the 1 per cent survival level. Hence, even with some modest bomber attrition the force required to inflict [redacted] per cent damage would be considerably smaller than even the normal ground alert force.

We will draw on recent RAND work that evaluates the efficiency of various S-L-S tactics in terms of the quantity and quality of bomb damage assessment (BDA) information. This work treats the general problem in a no-defense environment and considers: 1) ideal BDA, a limiting case of perfect information, in which after each shot the attacker knows whether the target has been killed; 2) miss-distance BDA in which the attacker merely knows the distance between the crater and the target.* Because of the statistical nature of the response of hard targets to nuclear effects, the miss distance does not necessarily tell the attacker what has happened to the target.

We have used the results of the S-L-S tactic based on the miss distance BDA since it probably most closely approximates the kind of information we can hope to obtain with real systems.**

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*M. Arnsten. Shoot-Look-Shoot at Hard Targets (U), The RAND Corporation, RM-3614-PR, August 1963 (Confidential).

**For the interested reader, we have taken our results from Figure 6, ibid., at a desired kill level of [redacted] per cent. We have assumed that more than two and less than an infinite number of looks represent a reasonable campaign. One enters the abscissa at the value of p_{K_i} depending on the target class (p_{K_i} = [redacted] for the ASM) and interprets the ordinate obtained as the expected number of reliable weapons required. Thus, for example,

For p_{K_i} = [redacted] ASM per target for [redacted] per cent damage level.

RESULTS

We display only the results of the calculations and omit evaluative comments, since these are to be found in the text of the report.

Soviet Posture I

Figure 3 of the text of this report shows the percentage of Soviet posture I hard missiles surviving after the low altitude bomber attacks as a function of the number of bombers assigned. The effects of differences in the initial missile force (the programmed OSD force and USAF proposed force) are shown as well as the effects of differences in the CEP with which a gravity bomb may be delivered from (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) The ordinate includes both the hard SS-5s as well as the SS-7s.

Soviet Posture II

Figure B-2 shows the total number of hard missiles surviving in posture II as a function of the number of bombers assigned in the USAF proposed force for a CEP of (b)(1),(b)(3):42 USC §. The effect of ideal BDA is seen to be negligible in this case primarily because of the low level of damage inflicted. Shoot-look-shoot tactics are most effective when the level of damage to be inflicted is very high (above (b)(1) per cent) and consequently, the marginal benefits of S-L-S tactics in this case are reduced to negligible proportions due to the increased attrition over the no S-L-S case.

Table B-12 shows the detailed results for a bomber force of (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) respectively, and corresponds to Figure 13 in the text.

Table B-13 shows the required allocation of ASMs in the improved U.S. force to reduce Soviet posture II hard missiles to the (b)(1) per cent survival level.

WILL SOVIET SAMs CONSTITUTE AN AREA DEFENSE?*

The preceding calculations of bomber strike outcomes assume that the bombers suffer attrition only from SAMs in the immediate vicinity of the targets they attack.

*This material draws on work by Thomas Brown.

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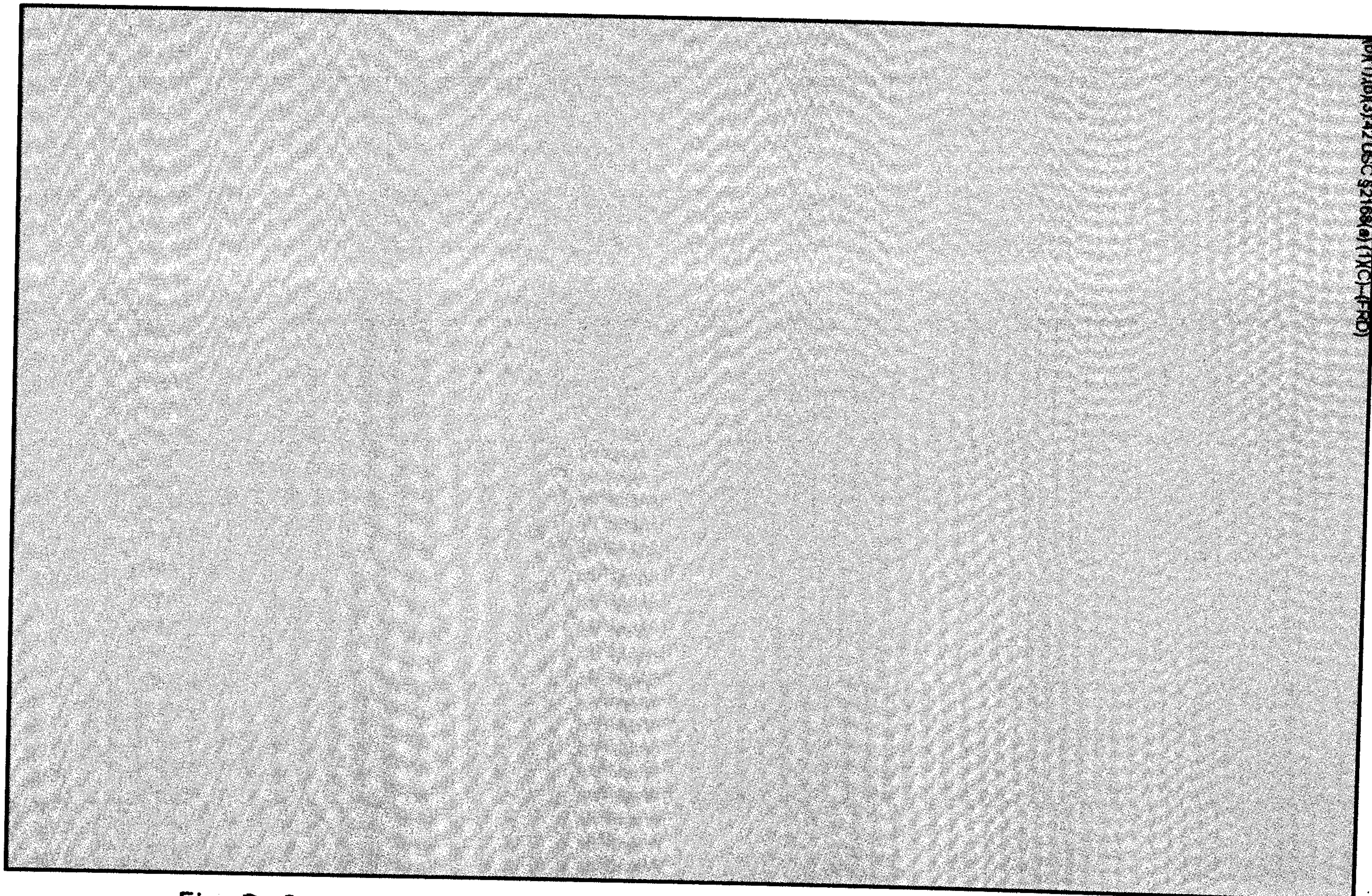

Fig. B-2 — USAF low altitude bomber attacks versus SU posture II

[redacted]

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Table B-12

OPTIMAL ALLOCATION OF USAF LOW ALTITUDE BOMBER ATTACKS VERSUS SOVIET POSTURE II HARD MISSILE TARGETS

Case	All targets in class uniformly attacked	Shoot-look-shoot (Ideal BDA)

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

Table B-13

IMPROVED U.S. FORCE REQUIREMENTS FOR (b)(1) [redacted] PER CENT KILL OF SOVIET POSTURE II HARD MISSILE TARGETS

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

Target class	[redacted]
Number of aim points	[redacted]
Number ASM aim points	[redacted]
Number ASM	[redacted]
Grand Total ASM	2650
B-52 force required (16 ASM, B-52)	165

With respect to area defenses, the grounds for this assumption are the large-scale missile attack directed at Soviet [redacted] In a detailed strike plan, the attack could probably afford to be more selective, ignoring some installations out of range of the bomber penetration paths. This section discusses the grounds for ignoring attrition which might be inflicted by SAMs on penetrating bombers en route to their targets. Consideration of this problem suggests that such attrition is unlikely to be significant, even without long, low-level penetrations by the bombers.

Figure B-3 gives an impression of a possible distribution of the Soviet SAMs in 1970, at the height of their buildup. The map shows approximately 1100 SA-2s and ~500 SA-3s. The locations were determined by AFNIN, and are intended to extrapolate past and current Soviet SAM deployment practices. They are not consistent with the earlier assumption in this Appendix that each hard missile is guarded by one SAM, but are probably a closer approximation to an area defense than such a missile-oriented defense would be. The circled unshaded areas are projected [redacted]

To illustrate the extent of the penetration problem posed by the SAMs, in Figure B-4 we show a possible penetration path through the area of densest SAM deployment, the shaded area of Figure B-3. If the B-52s were to fly the dog-leg course shown at high altitude, and the SAMs have a high-altitude range of 30 n mi against them, then the B-52s would come within range of only 12 SAM batteries if the bombers were able to navigate within a 12 n mi corridor. This result and the characteristics of other penetration paths through this area are shown in Table B-14. Even without long low-level penetration, a very small number of attacks against SAMs could permit the B-52s to penetrate through the most heavily defended areas. The SAMs do not appear to provide an area defense at high altitude if they are deployed as shown. The low-altitude coverage is, of course, much more sparse, as shown by Figure B-5, for the same area of Western Russia.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

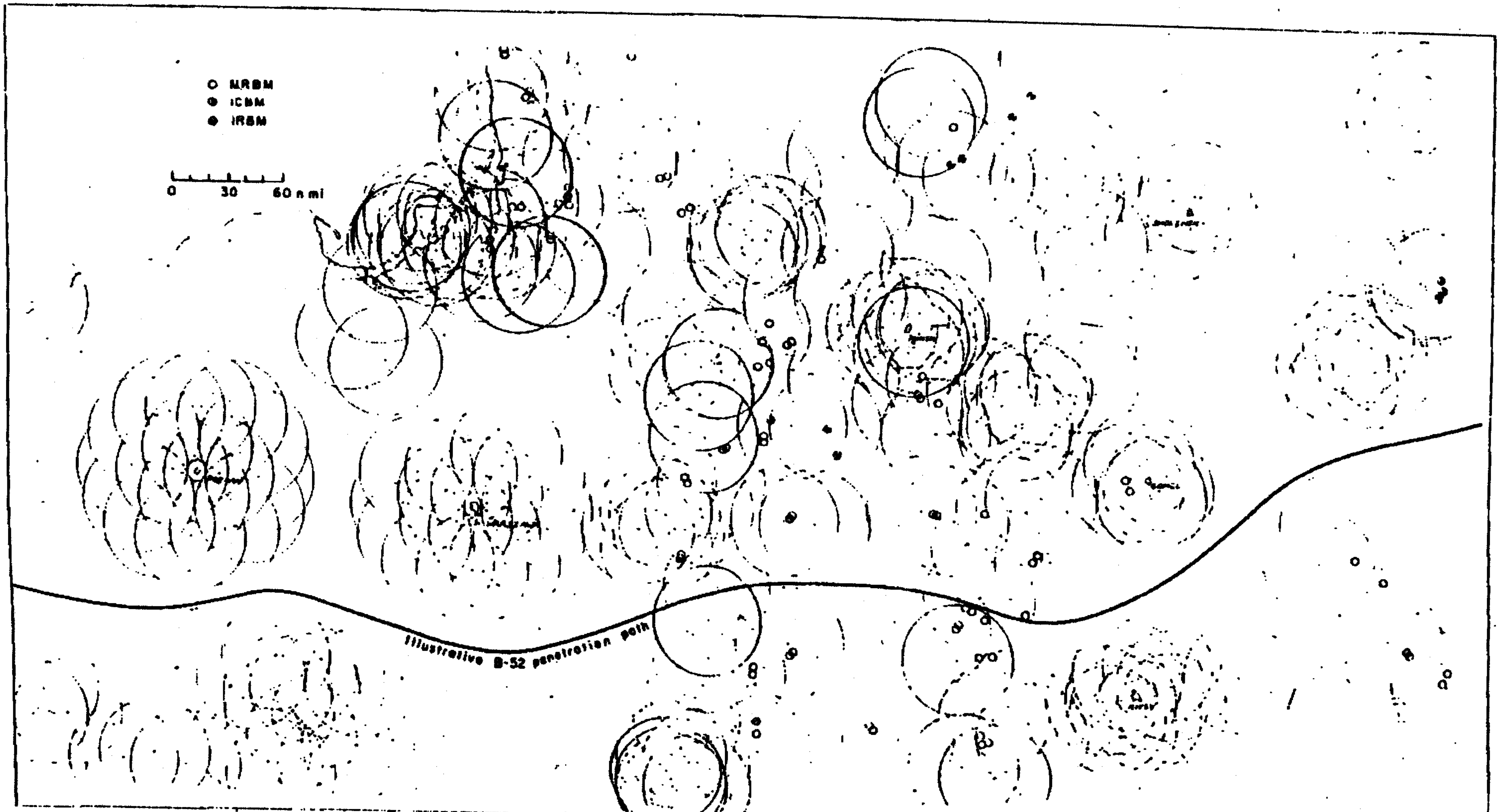

Fig. B-4 — A high-altitude penetration path through 1970 SAM defenses

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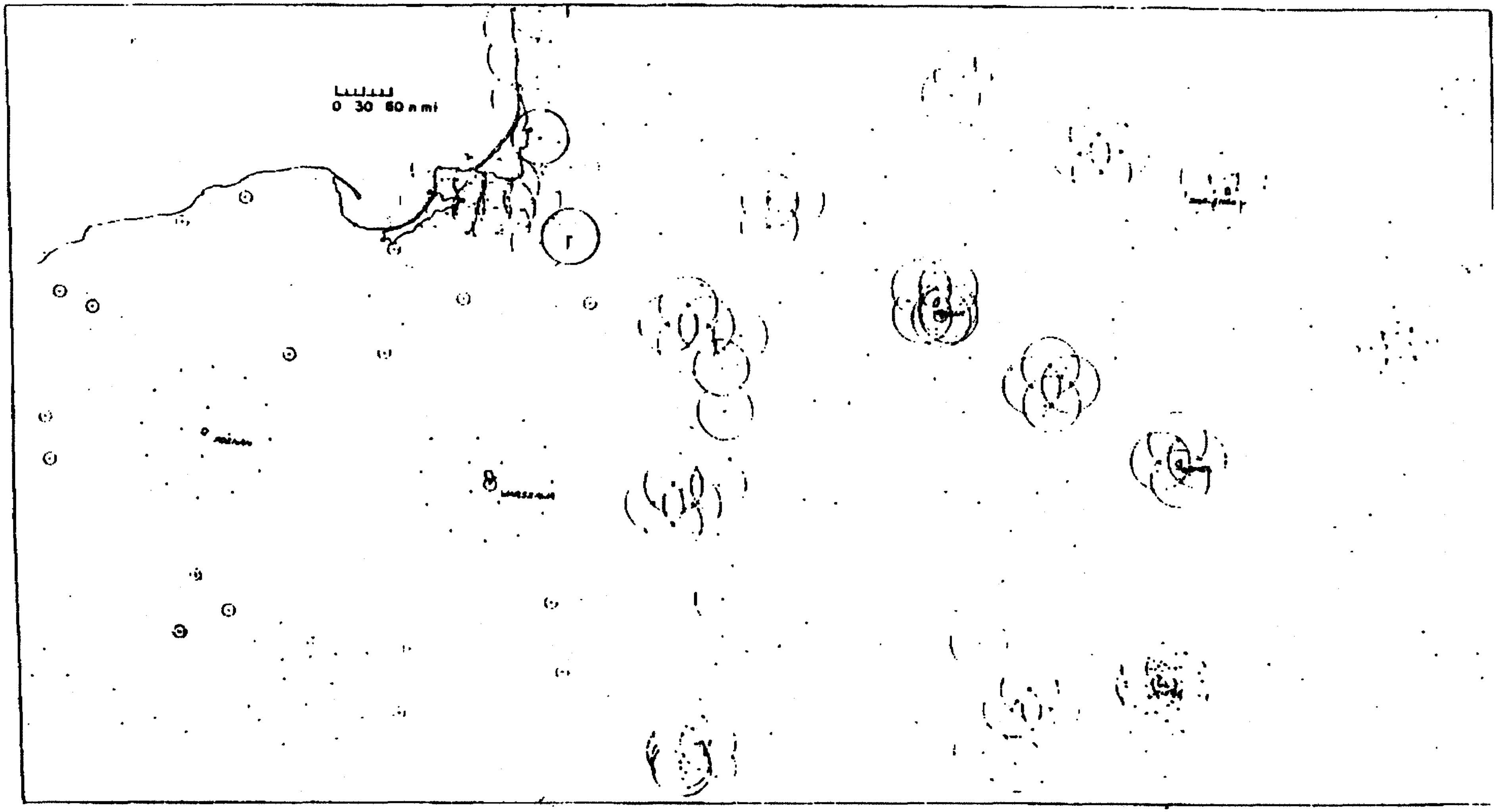

Fig. B-5 — Low-altitude SAM coverage

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Table B-14

PENETRATION ROUTES THROUGH WESTERN RUSSIA

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

Route	
Straight, High	[redacted]
Low, Evade SA-3	
High, South	
High, North	
High, South fly under barrier (one descent and one ascent)	

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Appendix C

ALLOCATION OF SOVIET INTERCONTINENTAL FORCES

THIS APPENDIX deals with that portion of the Soviet forces assigned to U. S. - [redacted] targets in the "counterforce reacting" Soviet strikes of the text. The cases presented in Figs. 7 and 18 are divided into two parts. The first is an allocation of ICBMs, SLMs, and bombers to military targets. This phase of the force allocation uses up all or almost all forces that can be launched by the Soviets during the opening minutes of the war and leads to the mortalities labeled "realized damage" in the text.

With certain exceptions discussed below, the damage potential is measured at various stages of the war by assuming that the counterforce strike is carried through unchanged, but that all surviving forces are used against urban targets. The effect of U.S. strikes on this damage potential is measured at various stages as if the forces for all further U.S. strikes did not exist. Hence it is assumed that all remaining Soviet forces have adequate time to retarget against urban targets, reload (in the case of back-up missiles), or recycle (in the case of recyclable aborts). The damage potential is the incremental mortalities inflicted by these forces. Total mortalities would be the sum of this and the realized damage.

In particular, once bombers are launched on counterforce strikes they are assumed to attempt to carry out these strikes. Since essentially all bombers are either launched early or destroyed, in effect all bombers are used against military targets. However, those surviving missiles not used in the initial counterforce strikes are allocated to urban targets.

The exceptions mentioned above are when the damage potential of the Soviet forces is measured before the first Soviet strikes -- before the war and. in the

U.S. preemption case, after the U.S. missile strike but before the Soviet counter-strike begins. In these cases the whole surviving Soviet force is delivered against urban targets and the total damage that would result is the damage potential itself, <u>not</u> the sum of the damage potential and the realized damage appearing on the figures (since the realized damage assumes a counterforce strike).

Relevant characteristics of Soviet postures I and II are summarized in Table C-1. The differences in offensive weaponry between these postures lies in the hard missile force. The shift from posture I to posture II is from SS-7Hs to a mix of SS-7Hs and SS-9Hs with an increase in the total number of missiles on launcher. However, since only the SS-7H is assumed to have a reload capability,* the reduction in reloads in posture II over posture I leads to the same total inventory of missiles on launcher plus reloads for both postures.

The missile payloads shown in Table C-1 are assumed to be modified when, in the case of the U.S. improved posture, they are used against targets under the protection of ballistic missile defense. Under such circumstances, the single warhead is replaced by a cluster of ten, each of one-twentieth the yield of the single warhead replaced.

Table C-2 summarizes the potential target systems in the United States and (b)(1) for the Soviet forces. Targets are also grouped by total population within four nautical miles to indicate the degree of civil collocation for blast effects.

The ICBM deployment is sufficiently deep to remove most of them from the target list of the (b)(1), whereas the MRBMs and IRBMs are within range of these forces. It is assumed that reload ICBMs can be fired before being subject to bomber attack, but that MRBMs and IRBMs cannot reload and fire before being attacked by theatre forces.

Two levels of operational readiness for the submarine force are assumed -- the lower level corresponds to a rate of 30 per cent at sea, the higher is comparable to U.S. Polaris performance. There comes a stage in most of the scenarios in which the remaining Soviet force is predominantly the submarine force at sea. Hence it is important not only how much of the force is assumed at sea, but also

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*A rationale for this is that reloads for the soft missiles are of no use considering the U.S. missile strike capabilities and that the silo configuration of the SS-9 would not lend itself to reloading.

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Table C-1

SOVIET 1970 INTERCONTINENTAL FORCES

			Basic Payload[a]		Operational Inventories	
	Reliability	CEP (n. mi.)	Yield (MT)	Fraction Fission	Posture I	Posture II

(b)(1),(b)(3) 42 USC §2168(a)(1)(C) (FRD)

Notes:

[a]See text for alternative payloads.

[b]Two per bomber.

[c]Combined takeoff to target reliability and penetration probability.

ATOMIC ENERGY ACT 1954

RESTRICTED DATA

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FORMERLY RESTRICTED DATA

HANDLE AS RESTRICTED DATA IN FOREIGN DISSEMINATION SECTION 144b ATOMIC ENERGY ACT OF 1954

Table C-2

COLLOCATION OF U.S.-[redacted]

(Minuteman excluded)

Offensive Weapon Carrier Points	Total No. Aiming Points	No. of Aiming Points by [redacted] Within 4 n. mi. (in thousands)					
		> 200	100-200	50-100	25-50	10-25	< 10
Soft							
Bomber and tanker bases	62	1	1	7	7	8	38
Alternative bomber bases	51	6	7	6	5	4	23
Atlas D, E launch sites	34					4	30
Subtotal	147	7	8	13	12	16	91
Hard							
Atlas F launch sites	74						74
Titan I launch sites	20						20
Titan II launch sites	57					1	56
Subtotal	151					1	150
Other Offensive							
Nuclear storage facilities	50	1	1	1	3	4	40
Military control hdqs.	70	11	6	6	10	5	32
Communication (incl. Gateway)	22	2	1	2	4	1	12
Ports	62	17	12	10	10	3	10
Recovery airfields	34	4	2	2	3	1	22
Subtotal	238	35	22	21	30	14	116
Defenses							
Fighters and SAGE	79	2	8	11	3	12	43
Alternate fighter bases	89	4	8	20	15	9	33
Subtotal	168	6	16	31	18	21	76
TOTAL OFFENSE & DEFENSE	704	48	46	65	60	52	433
Secondary Airfields							
Runway ≥ 6000 feet	194	5	12	9	20	19	129
Runway 4000 - 6000 feet	897	15	28	71	109	126	548
Subtotal	1091	20	40	80	129	145	677
GRAND TOTAL	1795	68	86	145	189	197	1110

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how much of this is used in the counterforce phases of the war. In both cases treated here about 23 per cent of the force is being used in the early missile strikes.

The remaining forces not in port can either be interpreted as at sea but not on-station. or as on-station but deliberately withheld to augment Soviet residual forces.

SOVIET STRIKE STRATEGIES

Two major variants in Soviet strike strategy are considered below. The first of these is the "counterforce reaction" of the text. Case 2 below appears in the dashed line bars of Figs. 7 and 18. These differ principally in the timing and magnitude of the urban strikes. They are:

1. Counterforce. Urban attacks, if any, are reserved for those submarine forces not used in the initial countermilitary strikes.
2. SS-8s and one-half bombers, urban. Urban attacks are included in the very first phases of the Soviet strike.

There are two arguments to rationalize the early timing of urban attacks in Case 2. The Soviets are presumed to recognize the unlikelihood of being able to destroy U.S. forces effectively, and employ a swift urban strike to terrorize, demoralize, and dissuade the United States from further military action of a general or non-general war nature. Although this tactic has only slight chance of success, they employ it in desperation.

The second argument has to do with the nature of the SS-8s. Against the diffused U.S. cities the SS-8 is an efficient city-buster which would make an important contribution to an urban force. However, it is a soft force, and so it must be used early. The SS-8 has some interesting countermilitary capabilities as well. and there are arguments for moving urban strikes to later in the war, as in Case 1.

An argument for the use of bombers in urban strikes can be made, as for the SS-8s, on the suitability of this large payload force for urban attacks. It can also be argued that by the time the bombers have penetrated, there will not be much in the way of countermilitary tasks left for them to do: surviving forces, for the most part, will have been launched, and those remaining will not be that important relative to the nontargetable Polaris.

In the summaries of mortalities below, that portion of the SLM force not used in the early strikes is always treated as a withheld potential threat, although Case 2 may be inconsistent in concept with this notion.

In the countermilitary strikes, no attempt is made to limit collateral civil damage. In fact, all weapons are groundburst, and military targets are attacked without regard to their collocation with civil population. A part of this rationale of the Soviet targeting used is that the complete destruction of U.S. retaliatory capability seems unachievable, hence the Soviet strikes turn to other military objectives, in particular the destruction of U.S. capability to support military operations in other parts of the world. To this end the countermilitary aspects of these strikes have as their objectives the destruction of strategic weapon systems; nuclear storage; debarkation ports; and military communications, command, and control. Urban attacks can also be considered to be a furtherance of the Soviet aim of destroying U.S. international influence.*

CONDITIONS OF OUTBREAK CONSIDERED

The range of outbreak conditions explicitly considered is limited to pre-emptive outbreak under conditions of relatively high alert. In particular, the Soviet strike "from the blue" with all forces peaked, timed, and targeted specifically for this strike is not developed.

It is assumed that the Soviets are limited in their capability to make adjustments in their strike plans and hence do not attempt to respond through such adjustments to day-by-day changes in U.S. force deployment** such as the implementation of an airborne alert, the dispersal of bombers or fighters, or the movement of submarines or ships in and out of ports. This makes their strike plans insensitive to many details of outbreak that may, however, affect how well these plans perform.

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*The Soviets often use phrases such as "governmental, economic, and administrative control center," which would indicate that their urban attacks might not be designed to maximize direct mortalities or casualties. However, the authors are using mortalities as an index, and therefore targeting is carried out to maximize this index.

**These things may, however, affect Soviet alert levels and willingness to respond to warning.

So far as developing Soviet strike plans and estimating U.S.-Canadian civil damage are concerned, the restriction of outbreak to preemptive conditions and the assumption of a relatively inflexible Soviet plan make it possible to bracket most of the relevant cases by considering two types of outbreak situations, that in which the first Soviet strikes are launched before any U.S. forces impact -- labeled *Soviet preemption* -- *and that in which the first U.S. strikes impact before* the Soviets launch their first strike -- labeled U.S. preemption.

POSTURE PAIRINGS TREATED

Of the many pairings of U.S. and Soviet postures considered in the text, only two are treated here. These are Soviet posture I versus the OSD posture and Soviet posture II versus the improved posture. Table C-1 summarizes the intercontinental forces of the two Soviet postures.

TARGETING

No rapid retargeting capability is used for the Soviet strikes. The counter-military portion of the missile, launcher, and reload missile strikes are essentially one option salvos. The targeting has been designed, however, so that those forces most likely to survive the U.S. strike are targeted against those targets of most interest to the Soviets under conditions of a U.S. first strike.

The E-class submarines are said to have a counter-aircraft carrier mission, and supposedly are not given strategic targets. Hence they are not used in the countermilitary attacks against North America. However, it is assumed that those on-station are used against ships at sea. The attacks of naval targets (ports) are assigned to naval forces (SLMs) where possible.

Tables C-3 and C-4 summarize the allocation of the counterforce reacting cases for postures I and II. The allocation for Case 2 differs only in the shifting of one-half of the bombers and the SS-8s to urban targets.* Bomber and tanker bases, as well as alternate bomber bases, nuclear storage sites, major military control and communications, and seaports are targets of interest even if the

*Bombers are assumed armed with AS-4s if used against locally defended urban targets.

Table C-3

COUNTERMILITARY ALLOCATION OF SOVIET POSTURE I ON OSD FORCE

	No. Targets	SS-7H	SLM Z, G, H	SLM Adv. Nuclear	SS-7S	SS-8S[a]	SS-7H Reload	Gravity Bombs
Over-all Delivery Probability								
SU preemption		0.8	0.7	0.7	0.80	0.80	.0.57	0.50
U.S. preemption		0.59	0.7	0.7	0.05	0.04	0.59	
Target Class								
Bomber and tanker airfields	[redacted] (b)(1)(b)(3) 42 USC §2168(a)(1)(C) (FRD)	124					124	
Alternate bomber airfields		51					51	
Atlas D, E launch sites		34					34	
Atlas F launch sites					74		74	
Titan I launch sites					20			
Titan II launch sites		2				40	4	
Minuteman LCC								
Minuteman launch sites								
Nuclear storage		100					50	
Military control-major		10			10			20
minor								120
Communications		22			22			
Sea posts-coastal		47	39	8				
inland		30		15			15	
Recovery airfields							68	68
Fighter fields & SAGE					79			
Alternate fighter fields					15			
TOTAL		420	39	24	220	40	420	208

Table C-4

COUNTERMILITARY ALLOCATION OF SOVIET POSTURE II ON IMPROVED FORCE

	No. Targets	SS-9H	SS-7H	SLM Z, G, H	SLM Adv. Nuclear	SS-7S	SS-8S	SS-7H Reload	Gravity Bombs
Over-all Delivery Probability									
SU preemption		0.75	0.8	0.7	0.7	0.8	0.8	0.51	0.25
U.S. preemption		0.63[a]	0.52[a]	0.7	0.7	0.04	0	0.52[a]	0
Target Class									
Bomber and tanker airfields	[redacted] (b)(1),(b)(3)(42 USC 2168(a)(1)(C)) (FRD)	124	12					62	
Alternate bomber airfields		51	51						
Atlas D, E launch sites		34							
Atlas F launch sites		52	22						
Titan I launch sites			20						
Titan II launch sites						57			
Minuteman LCC							40		
Minuteman launch sites									
Nuclear storage		100						50	
Military control-major		20							20
minor			60						120
Communications		22				22			
Sea ports-coastal				39	8				
inland		30	15		15				
Recovery airfields								68	68
Fighter fields & SAGE						79			
Alternate fighter fields						62			
TOTAL		480	180	39	24	220	40	180	208

Note: [a] Pindown would prevent the use of these weapons in the early strikes.

United States should launch before the Soviet strike; and these are targeted with the hard missiles and SLMs. The soft missiles augment the hard missile attack where it is somewhat thin, to go after some missile sites, and to do defense busting. The reload missiles augment the hard missile strikes and also attack recovery airfields, since these were not covered by the missiles on launchers. Those gravity bombs that are used for countermilitary purposes are sent against military control centers and recovery airfields.

The over-all delivery probabilities of the different weapon types for U.S. and Soviet preemption are included in Tables C-3 and C-4. This over-all delivery probability includes the probability of surviving U.S. attack, the probability of successful launch and, for the gravity bombs, the probability of successful delivery. It is assumed that reloads launch before the U.S. bomber attacks. The improved force includes some U.S. ballistic missile defense whose attrition is not reflected in the entries of Tables C-3 and C-4 since it is a function of the particular targets attacked. Combined reliability and penetration probability of the individual warhead in a cluster is taken to be 0.1 against ABM.

Tables C-5 and C-6 summarize the surviving and uncommitted Soviet forces at various stages of the campaigns. These are the forces that are used in calculating damage potential. Since the bombers are committed at the opening phases of the war, they are not included beyond that point. The missiles pinned down by the improved force are not destroyed. They are included in the damage potential, since they could eventually be used. Because they are pinned down and cannot be used against counterforce targets the residual force and hence the damage potential is increased, while the force used and the realized damage is decreased. This effect is most pronounced in between the U.S. missile attack and the bomber follow-on.

The possibility of pindown was not taken into account in the targeting of the Soviet forces. If it had been, the on-station SLM force might have been assigned targets other than or in addition to ports. Since the ports are responsible for a great deal of the realized damage, such an allocation shift might have led to a reduction in realized damage due to pindown beyond that indicated in the results.

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(b)(1)

Table C-5

SOVIET FORCES SURVIVING AND UNCOMMITTED AT VARIOUS STAGES OF THE CAMPAIGNS, POSTURE I VERSUS OSD POSTURE

[redacted]						
SU PREEMPTION						
Before war	220	420	420	40	419	120
After SU missile strike	11	21	420	2	126-314	16
After U.S. missile strike	1	15	310	0	30-218	0
After U.S. bomber strike	1	1	1	0	30-218	0
U.S. PREEMPTION						
Before war	220	420	420	40	419	120
After U.S. missile strike	14	310	310	2	323	5
After SU missile strike	1	15	310	0	30-218	0
After U.S. bomber strike	1	1	1	0	30-218	0

[redacted]

(b)(1)

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Table C-6

SOVIET FORCES SURVIVING AND UNCOMMITTED AT VARIOUS STAGES OF THE CAMPAIGNS, POSTURE II VERSUS IMPROVED POSTURE

(b)(1)

[redacted]

SU PREEMPTION							
Before war	220	180	180	40	480	419	120
After SU missile strike	11	9	180	2	24	323	15
After U.S. missile strike	0	6	118	0	20	30-218	0
After U.S. bomber strike	0	2	2	0	12	30-218	0
U.S. PREEMPTION							
Before war	220	180	180	40	480	419	120
After U.S. missile strike	10	118	118	0	403	128-314	0
After SU missile strike	0	6-118[b]	118	0	20-403[b]	30-218	0
After U.S. bomber strike	0	0-9[b]	0-9[b]	0	1-24[b]	30-218	0

[redacted]

[b] Lower number is without pindown, higher number is with pindown.

(b)(1)

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Appendix D

NATO AND COUNTER-NATO ALLOCATIONS

INTRODUCTION

THIS APPENDIX presents the NATO and counter-NATO weapon allocations. The NATO first strike was directed at [redacted]

Two alternate Soviet responses to this strike were computed -- a pure counterforce strike and a pure counterurban strike.

In its strike, NATO followed a relatively constrained counterforce doctrine. Because of the Soviet Union's immense damage potential against Western Europe, it was necessary to target [redacted] regardless of collocation. However, all weapons [redacted] were airburst, and the minimum yield required for a reasonable damage probability was used. In contrast, the Soviet response, whether counterforce or counterurban, is unrestrained. All weapons are groundburst.

EUROPEAN FORCES

It is extremely difficult to make NATO force projections for 1970. Political, military, and technical factors vary continuously. We therefore used a subset of all the systems that might be available to NATO in 1970 in carrying out the NATO initiations. Because of their problematical status, the NATO strike did not include

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[redacted] are attacked by intercontinental forces prior to NATO penetration.

the *TFX*, *VSTOL*, or *MMRBM*.* Polaris missiles *assigned to or belonging* to NATO were held in reserve. Despite these constraints, there were sufficient weapons in Europe to attack all targets of strategic importance in the satellites plus a set of interdiction targets, assuming that the 1970 NATO force structure will be similar to the 1967-1968 force structure.

The total inventory of systems employed in the NATO attack is as follows:

Light bomber	12
Fighter bomber	786
Light attack squadron	252 (Navy)
Heavy attack squadron	50 (Navy)
Fighter squadron	168 (Navy)
Pershing missile	213 (Army)

Range and loadings of both land and carrier-based fighter bombers were extremely flexible. It was convenient to treat *all fighter bombers as identical*. *The CEP for gravity bombs was taken at a* (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) and reliability of fighter aircraft was taken to be (b)(1),(b) Aircraft assigned to [redacted] and [redacted] carried (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) respectively. Weapons were airburst at (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) and groundburst at (b)(1),(b)(3):42 USC §2168(a)(1) Aircraft assigned to [redacted] carried (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) These were airburst. Attrition in the satellites and Soviet Union was (b)(1) per cent.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)
(b)(1),(b)(3):42 USC §2168(a) But (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) were not targeted.

Table D-1 presents the allocation of NATO forces to targets. Table D-2 *shows* what *happens* to Soviet *residual* European forces as the strikes arrive.

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*These forces can be substituted for other European forces. Assuming that the theater force remains constant in total numbers, but changes in composition, realized and potential mortalities would be approximately the same as those incurred with the forces used here.

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Table D-1

NATO WEAPON ASSIGNMENT

Target Areas	No. Targets	Fighter Bombers: Weapons per Target	Fighter Bombers: Weapons per Target Class	Pershings: Weapons per Target	Pershings: Weapons per Target Class
[redacted]					

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

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Table D-2

SOVIET RESIDUAL EUROPEAN FORCES

Case	SS-4 Before Missile Strike	SS-4 After Missile Strike	SS-4 After NATO Strike	SS-4 After Bomber Strike[a]	SS-5 Before Missile Strike	SS-5 After Missile Strike	SS-5 After NATO Strike	SS-5 After Bomber Strike[b]	SLMs[c]
OSD versus SU posture I	[redacted]								
USAF versus SU posture I									
USAF versus SU posture II									
Improved U. S. versus SU posture II									

(b)(1),(b)(3):42 USC §2168(a)(1)(C) (FRD)

Notes:

[a] SAC bombers do not reattack the [redacted] since doing so requires a fairly large expenditure of aircraft, and residual damage potential is not markedly reduced.

[b] SAC assignments to hard targets are independent of NATO targeting because of uncertainties about the availability of theater forces and attrition to them.

[c] Forty-five SLMs, including some from W-class submarines, are arbitrarily assigned to European targets.

SOVIET ALLOCATIONS

The Soviet residual damage potentials in Figs. 6. 15. 17, and 18 are derived by allocating residual [redacted] surviving the missile strike could not employ their refire capability before NATO forces arrived. The Soviet civil damage potential after the U.S. missile strike obviously would be much higher without this assumption.

In a Soviet counterforce response after the U.S. missile strike or the NATO strike, the Soviet Union uses the SS-4s and SS-5s against major [redacted]

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Appendix E

CIVIL DAMAGE CALCULATIONS

METHODOLOGY

THE BASIC SOURCE for the mortality estimates of the test has been the Quick Count model, an IBM 7090 program developed at RAND by L. H. Wegner, N. D. Cohen, N. A. Hanunian, and G. W. Armerding.* The geographic distribution of population is represented by a table of monitoring points. Associated with each point are the number of people, the geographic coordinates, and an index representing the size of the area represented by the point. This areal distribution is incorporated into the computation of blast damage.** Monitoring points are identified by a political subdivision such as state, province, or country. Population tapes have been prepared for United States- [redacted]

Blast damage computations employ an approximation to the "sigma curve" relationship between probability of damage and distance to ground zero adopted by AFNIN.*** The weapon radii for air and groundburst [redacted] weapons, the value of sigma (which shapes the damage function), and the exponent for scaling weapon radii to other yields are all inputs.

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*This model will be described in detail in a RAND Memorandum under preparation by L. H. Wegner.

**Strictly speaking, in addition to fallout damage, any combination of effects that can be represented in terms of a weapon radius -- for example, thermal damage -- could be computed by the model instead of blast damage.

***AFM 200-8, Nuclear Weapons Employment Handbook (U). Confidential.

Twenty wind charts, five for each season, have been prepared for each region for which there is a population tape. Fallout, blast, and combined fallout and blast mortalities can be computed for any subset of these wind conditions. In effect the program constructs fallout patterns and computes the maximum biological dose at each monitoring point as the first step in computing fallout mortalities. The maximum biological dose is computed by assuming a $t^{-1.2}$ decay law, a 10 per cent "irreparable" factor, and a recovery rate of 2.4 per cent per day.

The population of each political subdivision is allocated to three shielding categories. It is assumed for each shielding category that the radiation exposure factor has a normal distribution for which the mean and standard deviation are inputs. The biological response to radiation is represented by a cumulative normal distribution with the mean and standard deviation as inputs.

The combined result of multiple effects, either blast from more than one weapon or blast and fallout, are treated by assuming that at each monitoring point the probability of surviving one is independent of the probability of surviving the others. Table E-1 summarizes the values of those inputs that have remained fixed throughout the Quick Count runs of this study.

The three shelter categories are taken to represent (1) wood-frame houses, (2) basements, and (3) special shelters. The effective exposure factors are based on the assumption that people remain in shelters for two weeks. The dose received after the two-week period is one-tenth the natural outdoor dosage, to reflect the use of moderate protection measures.

The Urban Ground Zero Selector (UGZ Selector) is an auxiliary routine for the automatic allocation of weapons to urban areas. It allocates weapons in sequence to urban areas and aim points within urban areas. The desired ground zero for each weapon is chosen to approximately maximize expected mortalities on the basis of expected blast effects of the preceding weapons in the allocation. Although in principle this allocation could also take into account the expected blast damage from military attacks, this has not in fact been done. Nor is there any attempt to incorporate fallout effects in the allocation process. Both factors are, of course, included in the Quick Count computation of damage.

Table E-1

QUICK COUNT INPUT PARAMETERS -- MORTALITIES

Blast[a]

[redacted] groundburst weapon radius = 2.15 n mi

[redacted] airburst weapon radius = 3.00 n mi

σ = 20

Cube root scaling used for other yields.

Fallout

50 per cent lethal dose	=	450 roentgens
Standard deviation	=	100
Residual radiation level[b]	=	1750 $\frac{\text{roentgens/hr}}{\text{kiloton/square mile}}$

Shelter categories

	Mean shielding factor	Standard deviation
Category 1	0.5	0.1
Category 2	0.1	0.025
Category 3	0.02	0.005

Notes:

[a]These values correspond to a VN-T-K of 10-P-O and a scaled height of burst for airburst weapons of 500 ft at [redacted] For this vulnerability number and σ = 20, 4 per cent probability of death occurs at 4 psi, 50 per cent at 7 psi, and 90 per cent at 10 psi. See Nuclear Weapons Employment Handbook (U), AFM 200-8, Confidential, AFNIN, pp. 1-40, 41, and 52.

[b]The residual radiation level is the product of the gamma activity factor and the terrain shielding factor.

To supply coordinates of the DGZs of the military attacks, target lists of present target systems, supplied primarily by AFNIN, were used for the Communist Bloc and Western Europe. Where these lists needed augmentation to provide for future growth this was done by creating fake targets reflecting what seemed to be the emerging pattern for these target systems. Programmed force deployments from various sources were used to provide target lists for the United States [redacted] These gave fairly firm information except for Minuteman beyond Wing V. However, in all the Soviet strikes against the United States, the Minuteman list exceeded the number of complexes actually targeted so that its augmentation with fake targets was not necessary.

All the realized damage (damage from attacks on military targets) calculations of the text were computed by Quick Count runs, as well as a representative set of the damage potential (damage from attacks on [redacted] calculations, including at least one for each realized damage case. Further calculations of damage potential were made using the concept of <u>equivalent weapons</u>, discussed below.

Work with the MUSTARD model, a RAND-developed predecessor to the Urban Ground Zero Selector, has indicated that within the range of CEPs used (1 n mi and less) the [redacted] of weapons of different yields can be reflected with satisfactory precision by measuring the damage potential of an equivalent number of weapons of a standard yield.* The results with the Quick Count model have tended to corroborate this result.

In particular, let c(Y) be the (empirically derived) <u>effectiveness coefficient</u> of yield Y relative to a standard yield, Y_s. Let M(n) be the mortalities that can be inflicted by [redacted] attack of n standard yield weapons with a delivery probability p_s. Consider an attack involving k weapon types with n_i weapons of type i.

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*The MUSTARD model was developed by M. Lavin and D. Langfield and is described in M. Lavin, <u>Destruction Rate for United States City Resources in the Event of Nuclear Attacks</u> (U), The RAND Corporation, RM-2331-PR, January 1959 (Secret). The equivalent weapons treatment and data for computation of c(Y) are to be found in D. C. McGarvey and M. Beachley, [redacted] <u>Blast Damage in the United States and the Soviet Union by Zones -- An Application of the MUSTARD Model</u> (U), The RAND Corporation, RM-2690-PR, July 1961 (Secret), pp. 16-19.

each of yield Y_i *and delivery probability* p_i, $1 \le i \le k$. Then the total mortalities that this heterogeneous force can inflict is approximately $M(n_e)$ where n_e is the equivalent number of standard weapons, given by

$$n_e = \frac{p_1}{p_s} c(Y_1)\, n_1 + \frac{p_2}{p_s} c(Y_2)\, n_2 + \ldots + \frac{p_k}{p_s} c(Y_k)\, n_k \,.$$

(b)(1),(b)(3) 42 USC §2168(a)(1)(C)-(FRD) [redacted]

CIVIL DEFENSE ASSUMPTIONS

A "Standard Shelter Case" for the United States (b)(1) [redacted] has been developed for Quick Count by J. R. Lind and M. J. Penzo based on data on basements from the 1960 Census, Part I, of the Office of Civil Defense (OCD) shelter survey, and certain behavioral assumptions on the part of the populace. Sheltering occupancy has been developed on a state-by-state and rural-urban basis. As an input to Quick Count, however, the data have been aggregated so that all monitoring points in a state have the same distribution of population to shelter categories.

It is necessary to distinguish between number of shelter spaces available and number occupied. It is assumed that there are an unlimited number of Category 1 shelter spaces (houses) available, that the number of Category 2 shelter spaces (basements) available is in proportion to the fraction of dwellings that have basements, and that the number of Category 3 shelter spaces available is the total number of spaces with a protection factor of 100 or better (found in the OCD Phase I Survey). Actual occupancy is based on the data on shelter space available on a state-by-state basis and the assumptions that at least 5 per cent of the population is in Category 1, at least 5 per cent is in Category 2, no more than two-thirds of the Category 3 spaces are occupied, and that subject to these constraints the Category 3 shelters are occupied first, the overflow goes to Category 2 and the remaining overflow is put in Category 1.

The allocation of (b)(1) [redacted] population to shelters has been done on the basis of basement data. No Category 3 shelters are assumed for (b)(1) [redacted]

Table E-2 summarizes the total number of people sheltered in the United States under the Standard Sheltering Assumptions and also when additional shelters are purchased for Defense Programs A and B of the text. Program A is incorporated as part of the improved U. S. posture.

Table E-2

SHELTER OCCUPANCY ASSUMPTION SUMMARY -- UNITED STATES[a]
(millions)

--	Category 1 (houses)	Category 2 (basements)	Category 3	
			7 psi	15 psi
Standard program	73	72	33	0
Program A	5	57	67	49
Program B	5	35	60	78

Note:

[a]Based on a 1960 population of 178 million for each program.

Category 3 has been separated into two subcategories, those with blast protection of 7 psi and those with blast protection of 15 psi. Both subcategories are treated identically so far as fallout protection is concerned.

In Program A all people in the 10 largest urban areas are given special shelters with a protection factor of 100 or better. It is assumed that these are constructed or improved to yield 15 psi protection. Since some of these people already had Category 3 sheltering in the Standard Program, this phase of Program A increases the population in the Category 3 shelters by less than 49 million. An additional 50 million shelters of Category 3 radiation protection but with no particular blast resistance features are also purchased and located where needed. The result is a total of shelter spaces plus basement spaces in excess of the total population of the United States. Nonetheless it is also assumed that 5 million people receive Category 1 sheltering to reflect behavioral constraints. A similar allocation process was used for arriving at Program B. with the 78 million people in the largest 50 cities receiving 15 psi. Category 3 shelters. It is realized that the allocation of population to shelters is rough; however. the crudity of existing data on availability of shelters to population. behavioral assumptions. and costs of additional shelter spaces is such that further refinements are not justified.

There is an even greater paucity of information on Soviet shelter programs. As with the United States shelter programs for 1970 it is assumed that a certain degree of sheltering is initially available to which an expanded civil defense program is added.* On the basis of this data and certain population behavioral assumptions the per cent of the population in the three shelter categories has been determined oblast by oblast taking into account the urban-rural distribution of population in each oblast. This led to 146 million Soviet people in Category 1. 33 million in Category 2. and 30 million in Category 3. Additional shelter (see Appendix A) purchased for postures I and II leads to 76 million in Category 1. 33 million in Category 2. and 100 million in Category 3. In Category 3 there are about 20 million spaces of 15 psi blast protection located in the largest urban areas.

In the absence of civil defense preparedness or shelter programs for (b)(1) [redacted] (b)(1) [redacted] it has been assumed that all the population of these areas is in Category 1. Clearly existing basements in these areas could provide better protection provided there were means of instructing the population in their use. However it seemed best to make a pessimistic assumption rather than one that might involve unwarranted optimism.

BALLISTIC MISSILE DEFENSE

Ballistic missile defenses have been employed in all Soviet postures and in the United States improved posture. It seemed inappropriate to use a sophisticated attrition model in light of the uncertain configuration of either a U.S. or Soviet

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*The initial program for the Soviet Union was contructed by Lind and Penzo using data in A Comparison of Selected Effects of Clean and Normal Nuclear Weapons in War (U). Department of Defense Damage Assessment Center. Defense Atomic Support Agency. October 1962 (Secret-Restricted Data).

system. It was assumed simply that each attacking object had a [redacted] probability of penetrating the defenses. The civil defense assumption that the populace of defended cities was also protected by fallout shelters with a nominal amount of blast protection (15 psi) was accounted for by reducing the weapon radius of those weapons allocated to these cities or to military targets in them.

The shortcomings of this grossly simplified active defense model are probably most pronounced for large scale attacks. In small scale attacks aimed at maximizing mortalities, it would be preferable to bypass the defended areas unless the defenses were deployed at a larger number of cities than in either program A or B. When the attack size becomes large enough to include defended cities, optimal tactics--by the offense would call for concentrating the attack at a single target area until it was large enough to effect saturation or destruction of the defenses. Among the devices to facilitate this, the offense could use clustered warheads. Such multiple offense warheads would enable defense saturation with fewer boosters, as well as tending to exhaust the stockpile of defense interceptor missiles.

Comparison of the results of Fig. 9 with calculations that have attempted to take these factors into explicit account suggests that the results are not substantially different for attack levels below, say, [redacted] warheads. Moreover, where the Soviets are attacking with a force that has been heavily damaged by counterforce attacks, the surviving forces are unlikely to be those with optimal characteristics for penetrating antimissile defenses, unless a large part of the Soviet force, or an invulnerable portion of it, were so optimized. For larger attacks where the vulnerability and saturability of active antimissile defenses become important, and enemy forces optimized to penetrate defenses may be available, the curves of Fig. 9 based on the constant attrition rate model probably understate the damage from attacks aimed at maximizing mortalities. In addition, the curves of Fig. 9 do not reflect the level of property damage in the defended areas, which would be considerably higher than the level of population damage as a result of the population shelters.

Appendix F

U.S. AND SOVIET ECONOMIC DAMAGE POTENTIAL

I. UNITED STATES

INTRODUCTION

THE COST of a nuclear exchange is measured by realized civil damage. And the coercive power of the United States and the Soviet Union during a nuclear exchange is measured by the residual damage potential -- the maximum additional amount of civil damage each nation could inflict at any time with its surviving forces. Civil damage has been defined as equivalent to civil mortalities, because mortalities can sometimes serve as an index of economic damage, and because more is known about potential civil mortalities than is known about the ability of nations to recover from general war.

For several reasons, it is desirable to be more precise about the relationship of civil mortalities to damaged resources; that is, to be more precise about the relative likelihood of economic viability after general war. First, the coercive power of the United States during a general war would depend, in part, on judgments about the postattack viability of the United States and the Soviet Union. Second, the political outcome of a war will depend in part on the ability of the United States and the Soviet Union to repair and reorganize damaged economies. Third, both the United States and the Soviet Union may be interested in making limited, but hopefully credible, threats by implying that residual forces could be used in a controlled, discriminating manner against resources as well as against population.

In this Appendix we will not attempt to answer all the questions that arise when the socio-economic viability of nations during and after general war is used as an index of realized and potential damage. We will be concerned primarily with the balance between surviving population and surviving resources for the

United States and the Soviet Union in the four cases: OSD versus Soviet posture I: USAF versus Soviet posture I: USAF versus Soviet posture II: and improved U.S. versus Soviet posture II. We will attempt to make feasibility comparisons for each case and for each nation given alternative levels of damage and postattack economic requirements.

It should be evident that demonstrating the feasibility of reorganization and recuperation for given levels of damage and requirements does not imply that society can, indeed, recover from a general war. Although there may be no physical or technological barrier against recovery, a nation might not recover rapidly because of organizational factors. The economy's organizational web, the institutions providing directions and decisions for industry, may be damaged or disarrayed. And there are many questions about social behavior under severe stress and disaster. The answers cannot be predicted with confidence. However, if the economy attempts to operate initially at levels where surviving capacity is not adequate for meeting demands on that capacity, then even a good organizational base and productive social behavior will not be sufficient to prevent bottlenecks which could delay recuperation. To speak of postattack reorganization and recuperation, therefore, it is first necessary to demonstrate that surviving capacity is adequate to meet the expected postattack civilian and military requirements. If capacity is not adequate, then adjustments must be made in the level of civilian requirements, military requirements, or both.

The nature of these adjustments for a given set of industrial commodities will be examined here. For the Soviet Union we consider steel, machine tools, petroleum, hydroelectric power, and thermal power.*

ASSUMPTIONS AND DEFINITIONS

The following assumptions were made in studying the Soviet economy: (b)(1) [redacted]

*This is the only important set for which Soviet data is easily available on a geographic basis. Estimates of capacity are provided by AFNIN.

**The 15-mile criterion allows for most of the blast and thermal effects, for example, (b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD) [redacted]

[redacted]

3. The population, possessing 20 million special fallout shelters and 50 million improvised fallout shelters, is prepared to take shelter on warning.
4. Any industrial and agricultural problems created by fallout are assumed to be solvable once the population emerges from shelter.
5. Imports would not be available from the West.

An economy is viable after general war if it is capable of: (1) providing the bulk of surviving workers and their families with a level of consumption high enough to maintain their productivity; (2) meeting any need for postattack military operations; and (3) repairing and/or maintaining the stock of real capital required in accomplishing (1) and (2).

Viability is defined in this way because it may not be difficult to demonstrate that there is some low (equilibrium) level of population for which surviving resources would be adequate, even where destruction of resources was very large. We do not consider a society and economy viable if it suffers extremely large losses of population <u>after</u> a general war because it cannot maintain an organized pattern of life while continuing to use modern technology. Second, a society that cannot maintain or possibly augment its residual military forces may not be left free to reorganize and recuperate. Third, it is clear that the stock of surviving capital and the skills of the surviving population must be in balance before the above conditions can be met. Although some form of society and economy would probably reemerge if these conditions were not met, it might be at an extremely primitive level.

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*This criterion gives essentially a complete representation for the [redacted]

[redacted]

Table F-1 presents a rough index of the amount of resources associated with the counterforce target system presented by Soviet posture I and Soviet posture II. Since the Soviet Union and the European satellites are treated as a homogeneous nation for counterforce purposes, the economic capacity figures are the totals for the Soviet Union <u>and</u> the satellities, and the percentages for each resource category are computed using total capacity. There is no double counting within a given target system, but there is double counting between target systems for the reason mentioned above: There are many ways in which capacity can be destroyed, and we are interested in total damage, not incremental damage.

For 46 primary offensive heavy and medium staging bases the collocation of resources is quite low. [redacted]

The [redacted] have low collocations. The [redacted] in the Soviet Union. A few satellite fields account for the collocations for the other industrial categories. [redacted]

Of the [redacted] have essentially no collocation with industry. And the same is true for [redacted]

Neither the [redacted] have any industrial collocation except for a [redacted] in Soviet posture II have zero collocation.

The situation is somewhat different when we consider the [redacted] Within the Soviet Union, plants collocated with [redacted] However, most of the plants in these areas are at a distance from the DGZ such that damage probabilities are zero if Minutemen are used.

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Table F-1

COLLOCATION OF [redacted] (b)(1) -- SU POSTURES I AND II

(15-mile collocation radius)

[redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

Notes:

[redacted] which obviously is not a target in the counterforce phase of the war.

[redacted] which are not targets in the counterforce phases.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

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[redacted] by themselves.

Collocation of the [redacted] are ten miles or more from the DGZ, and damage probabilities from blast and thermal effects are very low.

Of the [redacted] alone. However, these fields are 9, 15, and 7 miles from the DGZs. Attacking [redacted] for example, with Type A or B Minutemen gives essentially zero damage probabilities for the [redacted] Finally, it is clear that only very small amounts of capacity are collocated with the [redacted]

From the analysis of the target system, it appears that the United States can deliver a counterforce strike that would leave [redacted] relatively intact after the counterforce strikes, and since much of the skilled population required to handle the capacity would also survive; and since there [redacted] the Soviets could probably reorganize and recuperate if the war ended with the counterforce phase, provided that the organizational structure remained intact and there was no adverse social behavior.

(b)(1) [redacted] STRIKES

Should U.S. residual forces be used in (b)(1) [redacted] strikes, Soviet viability would depend on the absolute losses, the ratio of (b)(1) [redacted] In other words, there is no unique level of damage below which a nation is viable and above which it is not.

Figure F-1 presents a rough idea of some of the variables involved in making a feasibility calculation for a given industry -- (b)(1),(b)(3):42 [redacted] The curve marked with numbers from 8 to 322 shows the percentage of (b)(1),(b)(3):42 USC §2168(a) (1)(C)-(F [redacted] surviving, using the residual forces in the OSD posture. The same curve holds approximately for the USAF posture. The numbers indicate the number of (b)(1) [redacted] areas attacked. The percentage of (b)(1),(b)(3):42 USC §2168(a) (1)(C)-(FRD) [redacted] (b)(1),(b)(3):42 USC §2168(a) (1 [redacted] of the capacity associated with each urban area attacked is destroyed. (Assumption 2 above.) The numbered dots to the right of the survival curve indicate what the (b)(1) [redacted] (b)(1),(b)(3):42 USC §2168(a) (1)(C)- [redacted] might be like if 100 per cent of the (b)(1),(b)(3):42 USC §2168(a) (1)(C)-(F [redacted] in a given area were destroyed.

The straight lines beginning on the ordinate indicate a specified final demand on surviving capacity -- that is, direct plus indirect demand -- for example, the 40 per cent Civilian Requirement line states that .4 per cent of preattack (b)(1),(b) [redacted] (b)(1),(b)(3):42 USC § [redacted] (b)(1) [redacted] Any point on or above the 40 per cent line satisfies this condition. Consequently, if the Soviets' postattack (b)(1),(b)(3):42 USC §2168(a) (1)(C)-(FRD) [redacted] (b)(1),(b)(3):42 USC §2168(a) (1)(C)-(FRD) [redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[redacted]

Fig. F-1—OSD versus SU posture I – residual U.S. economic damage potential

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[redacted]

[redacted] This fact is illustrated by the intersection of the 80 per cent Civilian Requirement line and the survival curve.*

According to our definition, however, an economy merely capable of supporting the population is not viable. Suppose that 10 per cent of initial [redacted] This situation is presented by the 80 per cent Civilian plus 10 per cent Fixed Military Requirement line. Obviously with such requirements, OSD or USAF forces would be adequate to prevent viability. If we impose the same military requirement and use the .4 ratio for [redacted] and the residual OSD and USAF forces are large enough to carry out this kind of attack.**

Figures F-2, F-3, F-4, and F-5 present the same kind of analysis for [redacted] The survival curve indicates that it would be very difficult to create bottlenecks in the [redacted] The requirements lines indicate that even an attack on [redacted] is imposed.

Even greater difficulty is encountered creating bottlenecks [redacted] Figure F-3 indicates that an attack on [redacted]

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*The .4 ratio of surviving capacity to population is suggestive because it is the minimum to which capacity may fall and provide the entire 1958 U.S. population with a 1929 standard of living. The .8 ratio is used here to indicate an upper bound, showing how difficult it would be to maintain such a standard. For extensive discussion of postattack requirements for the U.S. population, see D. V. T. Bear and P. G. Clark, <u>Which Industries Would be Most Important in a Postwar U.S. Economy</u> (U), The RAND Corporation, RM-2443-PR, September 1959 (Confidential); S. G. Winter, Jr., <u>Economic Viability After Thermonuclear War</u>, The RAND Corporation, RM-3436-PR, forthcoming; <u>Civil Defense - 1961</u>, U.S. Government Printing Office, Washington, D.C., 1961.

[redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

Fig. F-2—OSD versus SU posture I-residual U.S. economic damage potential

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

Fig. F-3—OSD versus SU posture I—residual U.S. economic damage potential

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[redacted]

Fig. F-4 — OSD versus SU posture I-residual U.S. economic damage potential

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[redacted]

Fig. F-5—OSD versus SU posture I – residual U.S. economic damage potential

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[redacted]

Of course, this would not be true assuming 100 per cent capacity per [redacted] were destroyed. The dots to the right of the survival curve indicate the [redacted] requirement would be prevented by an attack on [redacted] But even at this level of resource destruction the Soviets could easily afford the "40 + 10" requirement.

It is extremely difficult to create bottlenecks in [redacted] just as it *is extremely difficult to create bottlenecks in* [redacted] From Fig. F-4, an attack on [redacted] *with the residual* OSD or the improved U.S. forces still permits the *Soviets* to meet an *80 per cent civilian requirement* (.8 per cent surviving capacity for every 1 per cent of *surviving population)* plus a fixed 10 per cent military requirement. Given an *imposed* 25 *per cent fixed* military requirement, the Soviet Union could meet a civilian [redacted] requirement of 58 per cent. And this, by estimates for a postattack U.S. *economy,* is still fairly large.

Figure F-5 shows that the OSD or USAF residual forces would not be adequate in creating [redacted] bottlenecks if civilian requirements are below a ratio of .5 and if there are postattack military requirements.

Soviet prospects for viability are somewhat different when we consider the residual forces of the improved U.S. posture. The surviving population is larger than in the other cases because collateral damage is low. In supporting this larger surviving population, the Soviets become more sensitive to [redacted] Figures 5 and 6 present some calculations for [redacted] We omit discussion of [redacted] since the results are similar to the OSD and USAF cases.

Figure F-6 shows that if the Soviets attempt to maintain a .4 ratio of surviving [redacted] plus a 10 per cent fixed military requirement, an attack on [redacted] would prevent the requirement from being met. An attack on [redacted] would be required in the OSD and USAF cases. However, in all three *cases, if the Soviets attempt to satisfy only* [redacted] requirements near the *.4 level, the United States could not prevent* it, assuming the 80 per cent destruction criterion.*

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*If 100 per cent of capacity associated with [redacted] is destroyed, then an attack on [redacted] creates a bottleneck; and U.S. forces are adequate to do this.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

Fig. F-6 — Improved U.S. versus SU posture II — residual economic damage potential

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

The same situation occurs with respect to [redacted] The same "40 + 10" requirement implies that an attack on [redacted] would create a bottleneck with the improved U.S. forces. But inducing the same bottleneck in the OSD and USAF cases requires an attack on [redacted]

There are many permutations of civilian and military requirements that can be tried using Figs. F-1 through F-7. The conclusion to be drawn is that U.S. forces in all three cases would be capable of [redacted]

TARGETING ECONOMIC RESOURCES

During the middle and late stages of a general war, it may sometimes be prudent to make limited but credible threats by implying that residual forces would be used against economic targets. The purpose of strikes against economic targets would be to introduce an intermediate level in the escalation process between counterforce strikes and counterpopulation strikes and to cripple post-attack Soviet power without destroying population.*

Table F-2 presents resource rankings by per cent capacity and shows the collocation of population on a conservative 15-mile radius. For example, the top [redacted]

Some idea of the effects of targeting the resources in Table F-2 at the end of the counterforce strikes in the four cases can be obtained if we assume that all resources targeted are destroyed and all the population associated with the

*In the recent book, Soviet Military Strategy, the Soviets emphasize strikes at U.S. economic targets and political control centers, but do not explicitly mention pure population strikes. See RAND Report R-416-PR of the same title, April 1963.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

Fig. F-7—Improved U.S. versus SU posture II—residual economic damage potential

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

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(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

Table F-2

CONCENTRATION OF SOVIET [redacted] -- RESOURCE RANKINGS[a]

[redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

Notes:

[a]Collocated population includes population within a 15-mile radius from the resource and summed cumulatively.

[redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[e]List ends at 55 with 71 per cent total [redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

[f][redacted] same data may be obtained from Fig. F-10.

[g]List ends at [redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

(b)(1),(b)(3):42 USC §2168(a)(1)(C)--(FRD)

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resources is also destroyed. The economic targets have Q vulnerability numbers and are, therefore, sensitive to airburst weapons. Consequently, the only population mortalities from the economic targets would be from blast. Obviously, on a 15-mile collocation radius we are deliberately overstating blast mortalities, but the results would not be very different if we had precise calculations of blast mortalities from economic strikes.

Figures F-8 through F-12 present a feasibility calculation for alternative "bottleneck" strikes at Soviet industry after the counterforce strike. The 40 per cent requirements line is the only one drawn, except those for [redacted] [redacted] since it is evident that the Soviets would have great difficulty satisfying any requirements above that. For [redacted] would make it impossible to satisfy the 40 per cent requirement.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)–(FRD)

An attack on about [redacted] would make it impossible to satisfy the 40 per cent requirement in these industries. However, Fig. F-3 shows that it would require an attack on about [redacted] in OSD versus Soviet posture I or [redacted] in OSD versus Soviet posture II to reduce the Soviet Union to a "40 per cent civilian + 10 per cent fixed military" requirement. An attack on about [redacted] [redacted] in OSD versus Soviet posture I or [redacted] in improved U.S. versus Soviet posture II would not allow the Soviet Union to satisfy "70 + 10" requirement.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)–(FRD)

(b)(1),(b)(3):42 USC §2168(a)(1)(C)–(FRD)

(b)(1),(b)(3):42 USC §2168(a)(1)(C)–(FRD)

(b)(1),(b)(3):42 USC §2168(a)(1)(C)–(FRD)

(b)(1),(b)(3):42 USC §2168(a)(1)(C)–(FRD)

In all four cases, the United States has sufficient residual forces to attack any one of these [redacted] or all of them simultaneously while still maintaining a capability to inflict [redacted]

Since other industries are more sensitive to direct attack, weapons should not be allocated to [redacted] The payoff from targeting other resources would be higher.

If one of our measures of coercive power is the maximum amount of additional [redacted]

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

Fig. F-8—Targeting Soviet resources-

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

(b)(1),(b)(3):42 USC §2168(a) (1)(C)--(FRD)

[redacted]

(b)(1),(b)(3):42 USC §2168 (a) (1)(C)--(FRD)

Fig. F-9 — Targeting Soviet resources [redacted]

(b)(1),(b)(3):42 USC §2168(a) (1)(C)--(FRD)

(b)(1),(b)(3):42 USC §2168(a) (1)(C)-(FRD)

[redacted]

Fig. F-10—Targeting Soviet resources – (b)(1),(b)(3):42 USC §2168(a) (1)(C)-(FRD) [redacted]

(b)(1),(b)(3):42 USC §2168(a) (1)(C)-(FRD) [redacted]

(b)(1),(b)(3):42 USC §2168(a) (1)(C)--(FRD)

Fig. F-11 — Targeting Soviet resources (b)(1),(b)(3):42 USC §2168(a) (1)(C)--(FRD)

(b)(1),(b)(3):42 USC §2168(a) (1)(C)--(FRD)

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

Fig. F-12 — Targeting Soviet resources — [redacted] (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

SUMMARY

In all four above-mentioned cases U.S. residual forces, if used to their fullest extent purely against [redacted] are capable of preventing the Soviet Union from operating its economy at a high level. The Soviet Union would not be able to support both high consumption levels and large military forces. Of course, one way to [redacted] military forces after the war would be to push [redacted] but adverse effects on productivity could be expected under these conditions.

U.S. residual forces, however, would not be able to prevent the Soviet Union from recuperation if [redacted] were attacked. Even when all residual forces are optimized to [redacted] the Soviet Union could still allocate moderate amounts of resources for military forces while maintaining [redacted] This is true if the organizational structure of the Soviet Union is adequate to handle postwar problems.

The Soviet Union does seem to be acutely sensitive to direct attacks [redacted]

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II. SOVIET UNION

INTRODUCTION

Given four cases, three time periods, and several alternate Soviet responses, many contingencies would have to be examined in making a complete analysis of realized and potential damage to the U.S. economy. Fortunately, the economic effects of Soviet second strikes in the OSD and USAF cases tend to be similar. As a representative case, we will use Soviet posture I -- second strike -- versus OSD (no ABM). As a contrast to this case, we will consider Soviet posture II -- second strike -- versus improved U.S. (with moderate ABM defense).

For several reasons, we will restrict our analysis of urban or countervalue strikes in the two cases to the period after the U.S. bomber strikes. Before the bomber strikes, the Soviet residual damage potential is in a range where uncertainties about the ecological consequences of the war and the survival of a national organizational base begin to dominate feasibility calculations. In other words, the "scale" effects of the war -- the consequences of losing large numbers of people and resources in absolute terms -- may make reorganization and recuperation impossible even though the balance between surviving resources and surviving population permitted subsistence or better.*

(b)(1) [redacted]

Should the Soviet Union employ its damage potential after the U.S. missile strikes, the United States would face very serious problems in reorganizing its economy, given any of the three postures -- OSD, USAF, or improved U.S. However, the differences between the postures are great <u>after</u> the U.S. bomber strikes. These differences will be analyzed below.

<u>DATA BASE</u>

Some of the industrial categories that we will employ in studying the U.S. economy differ from those used in studying the Soviet economy, because the availability of data on a geographic basis differs. For the United States we will consider the recovery and military support industry (RMSI), survival industry (SURVI), government control centers (GOVCC), petroleum refining capacity (POL), power, and ports. RMSI is an aggregate made up of various three and four digit SIC (Standard Industrial Classification) manufacturing industries considered essential for economic recovery and the support of military forces. SURVI is an aggregate of industries considered essential in the support of surviving population, such as food processing, textiles, medical supplies, and so on. GOVCC is defined as the set of Federal offices and state capitals providing public services and insuring political continuity.*

RMSI and SURVI capacity are measured by manufacturing value added. GOVCC capacity is measured by assigning arbitrary "importance" units to government offices. Petroleum refining capacity is measured by thousands of barrels per calendar day; power capacity is measured by kilowatts of installed capacity, and port capacity is measured by number of berths.

It should be emphasized that our calculations of realized and potential damage to these industries are only illustrative of the economic damage the United States might suffer in a general war. The original data are very highly aggregated,** and because some urban areas in Quick Count are a composite of many cities, it was necessary to aggregate the economic data still further to correspond to the

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*Data on these categories are provided by National Resource Evaluation Center, <u>Organization of Risk</u> (U), June 30, 1961 (Secret).

**See Winter, <u>op. cit</u>., pp. 195-202, for a discussion of the economic data.

Quick Count urban areas. Consequently, we can derive only very gross estimates of the concentration of resources per urban area. However, some quantitative perspective can be achieved by proceeding parametrically; that is, by comparing the loss of population in a given area and specifying a given fraction of resources in that area as also destroyed.

We make the following specific assumptions:

1. All industrial capacity within 15 miles of a military target is assumed to be associated with the target. Each military target system is treated independently.
2. The population is prepared to take shelter on warning.
3. If an urban area has ballistic missile defense, then a port associated with the urban area also has ballistic missile defense.
4. In counterforce plus counterurban strikes, 20 per cent of resources per port in a defended area are assumed destroyed, and 50 per cent per port in an undefended area.
5. Resources destroyed in urban strikes are roughly proportional to population destroyed. In the OSD case this means that approximately 80 per cent of resources per urban area attacked are destroyed. In the improved U.S. case, 60 per cent of resources per urban area attacked are destroyed.
6. Industrial and agricultural problems created by fallout are solvable once the population emerges from shelter, up to a level of 50-60 million mortalities.

SOVIET PURE COUNTERFORCE STRIKES

Table F-3 presents the percentage of industrial capacity collocated with the OSD target system, given a 15 mile collocation radius. There is no double counting within a target system, but there is double counting between target systems.

The 52 bomber fields, 9 tanker bases, and 34 recovery bases exhibit only a slight degree of collocation. The 51 alternate bomber bases have a greater collocation since many of them are in cities. Eight of the alternate bomber bases contribute most of the collocation. These eight are Lambert (St. Louis), O'Hare (Chicago), Idlewild (New York), Westchester (New York), Cleveland, Dobbin

Table F-3

PERCENTAGE OF INDUSTRIAL CAPACITY COLLOCATED WITH U.S. TARGET SYSTEMS

	Recovery & Military Support Industry	Survival Industry	Government Control Centers	Petroleum Refining Capacity	Total Power Capacity	Total Ports
9 Tanker bases	1.1	0.8	0	0	0.6	5.2
52 Bomber fields	3.1	2.6	5.9	3.4	3.5	6.6
51 Alternate bomber bases	16.4	15.4	15.1	11.3	9.3	36.6
8 Alternate bomber bases	11.6	13.0	3.6	4.4	6.6	22.8
29 ADC fighter bases	3.9	4.3	2.0	7.5	2.4	7.3
24 TAC fighter bases	3.8	4.5	1.8	2.7	2.7	7.8
89 Alternate TAC fighter bases	33.0	30.7	14.9	32.9	17.7	55.3
11 Alternate TAC fighter bases	15.5	13.3	3.1	24.0	6.4	23.0
18 SAGE	1.7	1.4	1.2	0.1	1.0	3.3
[redacted]	3.8	4.4	1.1	7.0	4.4	8.1
70 Military control headquarters	26.1	24.2	59.6	21.4	14.9	48.4
10 Military control headquarters	17.8	11.5	45.9[a]	19.0	8.7	41.7
22 Communications centers	9.8	7.7	3.2	5.8	4.6	7.2
62 Ports	43.3	37.9	6.1	59.6	24.9	81.4
9 Defended ports (improved U.S.)	29.0	25.1	5.9	24.8	12.8	46.4
9 Largest ports	13.4	16.9	3.9	20.6	9.6	50.9
108 Atlas launch sites	0.3	0.1	0.2	0.9	0	0
20 Titan I	0	0	0	0.3	0	0
56 Titan II	0.1	0	0	1.4	0.2	0
1300 Minuteman silos	0.1	0	0	0	0.1	0
130 Launch control centers	0	0	0	0	0	0
34 Recovery bases	16.4	9.6	2.6	5.9	5.2	12.1
3 Major recovery bases	13.7	8.1	1.4	4.3	3.7	8.4

Note; [a]Washington contains 41.9 per cent of government control centers.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

(Atlanta), Seattle, Stapleton (Denver), and Andrews (Washington). These fields, however, are at a distance from DGZs where blast and thermal damage to industrial structures should be small.*

Twenty-nine ADC fighter bases, and 24 TAC fighter bases also have low collocations. The 89 alternate TAC fighter bases, like the alternate bomber bases, are highly collocated. Eleven of them contribute a large fraction of the total collocation. The distances of the urban areas from the DGZ are such that some damage to the resources could be expected primarily from thermal radiation.

(b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD)

[redacted]

Missile collocation is almost nonexistent. The 1300 Minutemen in the OSD posture were not targeted at all. Even with the larger numbers of Minutemen in the USAF and improved U.S. cases collocation remains zero.

If the counterforce strike were limited to the target systems discussed above, the United States would probably experience only moderate difficulty in reorganizing the economy. But in both cases military control headquarters and ports are also targets. The 70 military control headquarters naturally have very high degrees of collocations because many of them are in major cities, for example, Washington, New York, and Los Angeles. Ten of the control headquarters contribute most of the collocation. Only these ten were attacked in Soviet posture I versus OSD whereas all 70 were attacked in Soviet posture II versus improved U.S. A few control headquarters are in cities with ballistic missile defenses in improved U.S.

*It should be remembered that the total amount of resources per urban area is considered concentrated at a given point. It is the distance from the resource point to the DGZ that we are measuring. In reality resources are spread about the DGZ.

The 62 ports have even a higher degree of collocation than the control headquarters. In both cases, all 62 ports were attacked. However, in Soviet posture II versus improved U.S., nine of the ports are at cities with ballistic missile defense. The collocation pattern of the nine defended ports is shown below that of the 62 ports. For comparison, the collocation patterns of the nine largest ports (ranked by berths) are also shown. The nine defended ports contain almost as much port capacity as the nine largest ports. Five ports are in both categories -- New York, Philadelphia, Los Angeles-Long Beach, Detroit, and San Francisco. They account for a large part of the collocation in either category.

It is, of course, extremely difficult to make economic damage assessments for the strikes on control headquarters and ports. There is no model that permits us to compute economic damage the way we compute mortalities.* However, we can make some rough comparisons. We know that in Soviet posture I versus OSD the total mortalities suffered in counterforce strike would be about 38 million, or 21 per cent.

If we assume that the counterforce strike in Soviet posture I versus OSD against all target systems except control headquarters and ports caused minimal economic damage, then a rough estimate of the total economic damage from the strike can be derived by taking different fractions of the resources associated with the ports as being destroyed, since the ports and control headquarters (particularly the major ones) are collocated.

Assuming that 50 per cent of the resources associated with the ports (this criterion overstates damage from the port attack alone) the United States would have a ratio of surviving resources to surviving population of .98 in RMSI, 1.02 in SURVI, 1.23 in GOVCC, .89 in POL, 1.1 in power, and .50 in ports. Estimates suggest that these ratios are far in excess of those required to support the surviving population at even a relatively high standard of living.** Assuming that

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*The PARM model of the National Planning Association promises to do this. See F.W. Dresch, Review of Research on the Supply-Requirements Problem, Stanford Research Institute, February 1962.

**Winter, op. cit., pp. 96-115. The ports could be a bottleneck if imports of some commodities were required. But it should not be difficult to find ways of landing commodities even where port facilities have been destroyed.

100 per cent of the resources collocated with ports are destroyed, the ratios are .72 for RMSI. .65 for SURVI. 1.19 for GOVCC. .50 for POL. .94 for power. and .24 for ports. The ratios here are still well above the levels that might be required to support the population at an austere standard of living, although it could not afford a standard close to the current one.*

Even if capacity were needed for military requirements, the surviving population in Soviet posture I versus OSD should be able to enjoy more than an austere standard of living. For example, suppose, in an extreme case, that 100 per cent of the resources in ports are destroyed, and 25 per cent of preattack capacity is needed for postattack military requirements. Then we have ratios of surviving usable resources to surviving population of .40 in RMSI, .47 in SURVI, .87 in GOVCC. .19 in POL, and .64 in power. Except for POL these ratios would permit the population to live at, say, a 1929 standard of living and devote large quantities of resources to military purposes. Petroleum by assumption could be imported. and it should be possible to either stockpile or build portable oil refineries.

In Soviet posture II versus improved U.S. (no pindown), should the Soviet response be a counterforce strike, U.S. prospects should be even better because some of the control headquarters and ports have ballistic missile defenses. Assuming that 20 per cent of capacity associated with defended ports is destroyed and 50 per cent of capacity in undefended ports, ratios of surviving resources to surviving population are .99 in RMSI, 1.0 in SURVI, .83 in POL, .02 in power. and .83 in ports. Since the surviving U.S. population is larger in Soviet posture II versus improved U.S. than in Soviet posture I versus OSD, and the ratios are similar, this means that the United States would be able to support a larger surviving population at a relatively high standard of living. Furthermore, in absolute terms, not as much damage has been done to the civilian organizational structure as was done in Soviet posture I versus OSD.

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*Petroleum might be a bottleneck, but it could probably be imported.

COUNTERFORCE PLUS COUNTERURBAN STRIKES

Figure F-13 shows what would happen if, after the Soviet counterforce strike in Soviet posture II versus improved U.S. (no pindown), remaining forces were used to attack [redacted] The survival curves indicate the percentage of [redacted] (b)(1),(b)(3):42 USC §2168(a)(1)(C)-(FRD) The survival curves begin with [redacted] and with various levels of resources surviving. The latter were computed using the following assumption: For New York, Chicago, and Philadelphia, which are the three defended cities attacked, 20 per cent of resources are assumed to be destroyed. In all other cities, 50 per cent of resources are assumed to be destroyed. These percentages were selected to allow for destruction of resources in the counterforce strike and to parallel population losses.

The requirements lines have the same meaning as in Figs. F-1 through F-12. All survival curves are well above the 50 per cent CR + 10 per cent FMR line. This means that the United States could, after the Soviet strikes are over, provide consumers with an austere standard of living and still provide for military forces.

However, this analysis gives too much weight to the loss of port facilities. The inportance of port facilities in the reorganization effort is open to question, because improvised facilities may be adequate. If ports are ignored, then with the same 10 per cent military requirement the United States could satisfy a 64 per cent civilian requirement, that is, .64 capacity in every industry for every 1 per cent of surviving population. And this level is estimated to be above subsistence.

If petroleum imports are available or there are large stockpiles, petroleum also may be given too much weight. Petroleum bottlenecks may be easy to handle. Ignoring the survival curves for petroleum and ports, then the maximum civilian requirement the economy could meet after the counterforce plus counterurban

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*The counterforce plus [redacted] (b)(1) attack in Soviet posture I versus OSD places mortalities in a region where uncertainties about [redacted] (b)(1) (b)(1) (b)(1) can be shown to be above austere levels.

**The [redacted] (b)(1) selected are those that, if attacked with remaining forces, would [redacted] (b)(1)

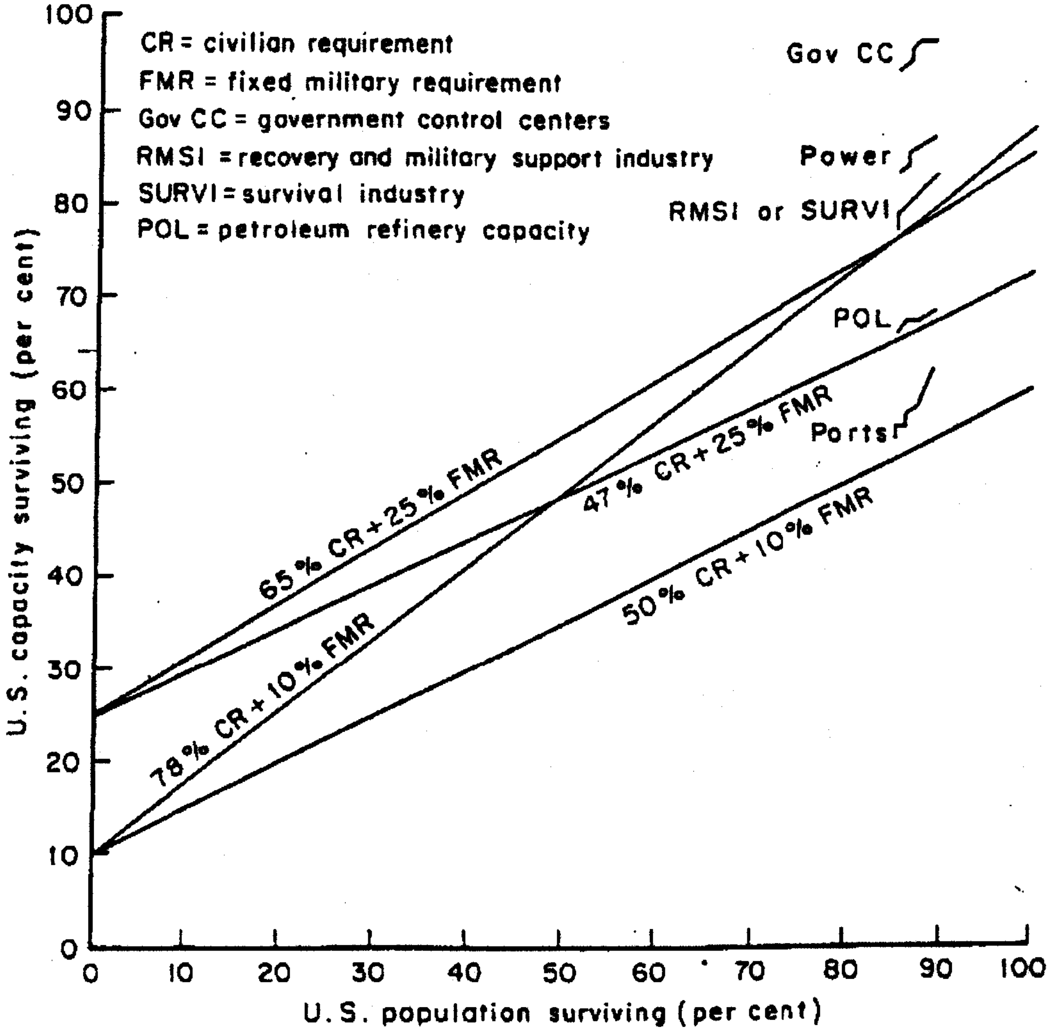

Fig. F-13 — SU posture II second strike versus Improved U.S. (conterforce + counterurban) response would be 78 per cent. or .78 capacity for every 1 per cent of surviving population, which is relatively high.

The 47 per cent CR - 25 per cent FMR line shows that the United States could meet a civilian requirement of a ratio of .47 surviving resources to surviving population while maintaining 25 per cent of initial capacity for military purposes or other governmental activities. If petroleum is not a bottleneck and the United States wishes to retain a 25 per cent fixed requirement, then the ratio of surviving resources to population can rise to .65.

Since surviving resources in the United States probably would be adequate to provide a standard of living above subsistence, and since the government control centers are relatively intact after the counterforce plus counterurban strike is completed, the United States should be able to carry out an extensive reorganization effort and sustain rapid economic growth.* Such a conclusion should of course always be qualified by noting that the effect of a general war on the U.S. organizational structure and on behavior of the population is uncertain. Because of the ballistic missile defense and the small Soviet force, however, only three of the top ten largest cities were attacked. Only 24 cities in all were attacked. Many of the public and private institutions that direct the economy are in the ten largest cities. And cities below the top ten are not entirely destroyed. Consequently, it would be difficult to argue that organizational problems might make reorganization and recuperation impossible even though it was economically feasible.

PURE COUNTERURBAN STRIKES

Figures F-14 and F-15 present the Soviet residual damage potential after the U.S. bomber strikes for Soviet posture I versus OSD and Soviet posture II versus improved U.S. In both cases, the Soviet Union fires 111 SLMs in an urban attack designed to maximize mortalities. The differences in the shapes of the survival curves result from the different urban areas attacked in each case. Because there

*It should be remembered that RMSI and SURVI are both aggregates, and there may be bottlenecks in the specific industries composing them. However, substitution possibilities probably would alleviate the problem.

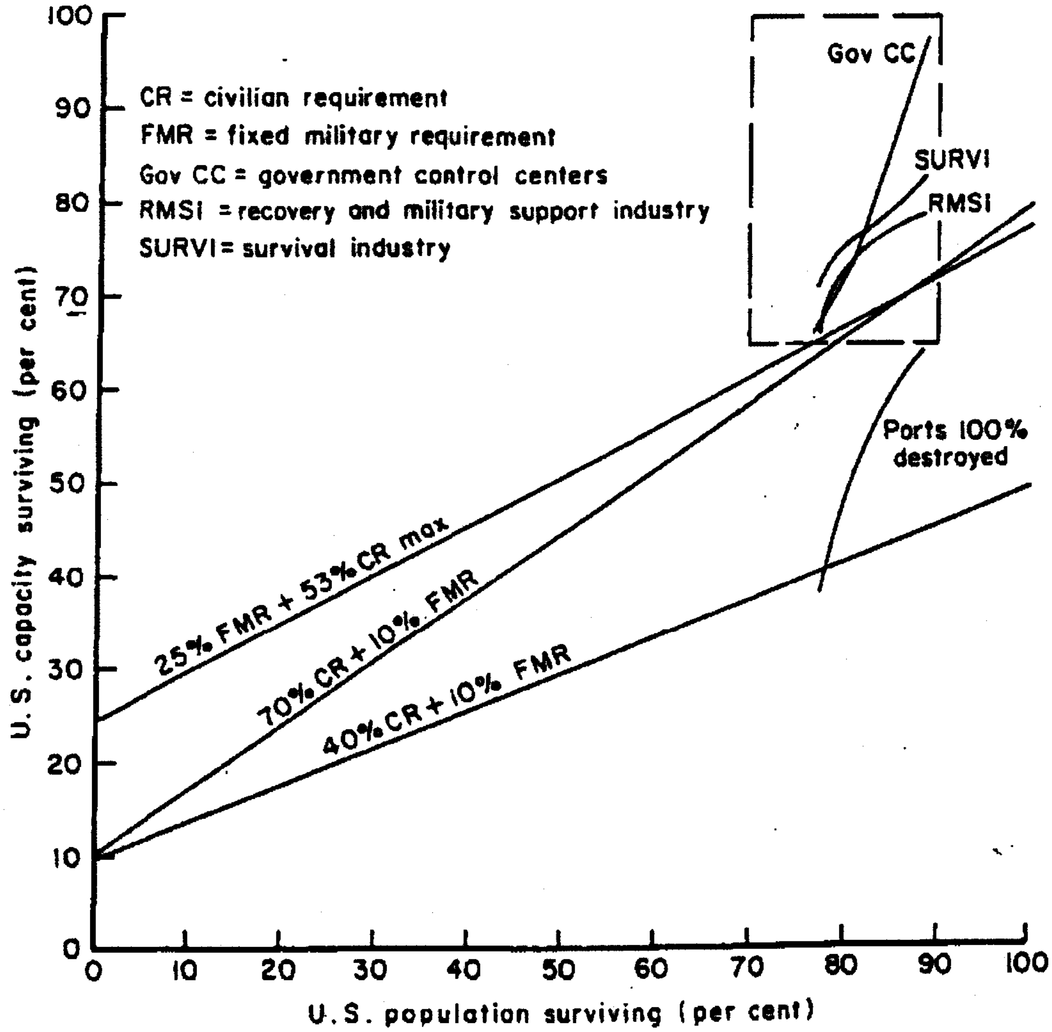

Fig. F-14—SU posture I second strike counterurban only versus OSD (after U.S. bomber strike)

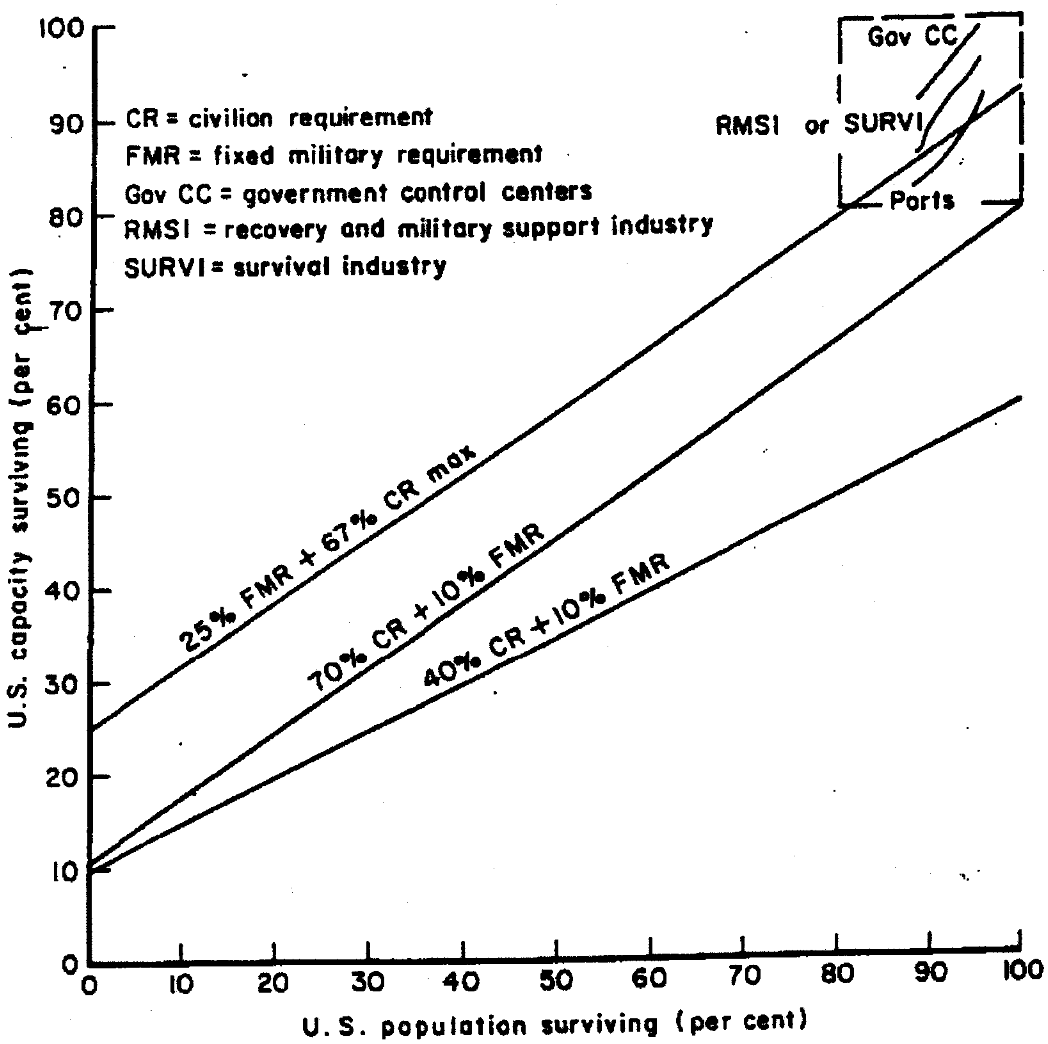

Fig. F-15—SU posture II second strike counterurban only versus Improved U.S.
(after U.S. bomber strike)

are no ballistic missile defenses in Soviet posture I versus OSD, roughly the top 40 cities ranked by population were attacked. Sixty undefended cities, rank 11-70 in population, were attacked in Soviet posture II versus improved U.S., because the optimal tactic with small numbers of SLMs facing ballistic missile defense is to attack only the undefended cities.

Eighty per cent of resources per urban area were assumed to be destroyed in Soviet posture I versus OSD, except for ports, where 100 per cent per urban area was assumed to be destroyed.* The survival curves in Fig. F-14 reflect this assumption. For simplicity not all of the curves are shown, but the petroleum and power curves lie close to the SURVI curve. The box around the curves indicates a "zone of viability" in which all curves except ports are contained.

Many capacity and requirement combinations can be explored with Fig. F-14. It is clear that the United States can meet the 40 per cent CR + 10 per cent FMR requirement even when 100 per cent of the ports are destroyed.** Ignoring ports, all survival curves lie above the 70 per cent CR + 10 per cent FMR line indicating that this relatively steep requirement can be met.

The requirements line marked 25 per cent FMR + 53 per cent CR max is derived in a different way from the lines used previously. Given the survival curves, we may ask what maximum civilian requirement the United States can meet if a fixed military requirement is specified. For a 25 per cent FMR, the economy can provide a 53 per cent CR, that is, a ratio of .53 of surviving resources to surviving population.*** This ratio is well above the .4 ratio estimated to give the surviving population a 1929 standard of living.****

Figure F-14 should be compared with Fig. F-15. Because of lower population densities and resource concentrations in the undefended cities, the survival curves

*The port facilities are heavily concentrated in the top five cities. An 80 per cent destruction criterion for ports would shift the port survival curve up and to the left but would not change the analysis.

**The port survival curve is almost tangent to the 40 per cent CR + 10 per cent FMR line. It actually cuts the line when 35 cities are attacked. For reasons previously given, we will ignore ports.

***For a 10 per cent FMR, the maximum civilian requirement that can be met is .72.

****A 1929 standard of living is obviously well above subsistence.

in Fig. F-15 are based on a 60 per cent destruction criterion including ports. Again, not all of the curves are drawn since they lie very close to each other, and, in fact, one curve serves for both RMSI or SURVI.

The survival curves of Fig. F-15 are well above the 70 per cent CR + 10 per cent FMR line. If ports are ignored, the United States, given a 10 per cent FMR, could satisfy a civilian requirement of 80 per cent, which should provide a standard of living close to the present one, and this for a larger surviving population than in Soviet posture I versus OSD. In other words, if the Soviet Union used its residual forces in an optimal way (maximizing mortalities in each case) the improved U.S. posture implies that a larger surviving population could enjoy a higher postattack standard of living compared with the standard that might occur given the OSD (and USAF) postures. Furthermore, the economy in the improved U.S. posture probably would have fewer organizational problems than the economy in the OSD (and USAF) postures, because the largest cities were not attacked.

TARGETING ECONOMIC RESOURCES

The residual Soviet forces in either case are not large enough to target large quantities of resources as well as population. However, if the Soviet Union attempted to target some of the SLMs against urban areas ranked by resource concentration, the improved U.S. posture would be superior to the OSD (and USAF) postures in limiting economic damage.

The top ten urban areas ranked by RMSI contain five areas with ballistic missile defense, and as in targeting population with small forces, the optimal tactic would be to attack only undefended resources, which are not as concentrated. Therefore, damage would be less.*

The top ten urban areas ranked by SURVI contain six defended areas in the improved U.S. posture. Should the Soviets target according to SURVI, the ballistic missile defenses of the improved U.S. posture should limit economic damage compared with OSD and USAF with no defenses.

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*Conversely, should the Soviets attack the defended resources, the ballistic missile defenses would help in reducing economic damage in two ways. Realized damage in the attacked areas would be lower than without the defense, and fewer missiles would be available for undefended areas. The conclusion, it should be emphasized, only holds for small numbers of missiles.

Power and petroleum capacity are not as highly collocated with major urban areas as RMSI and SURVI. But the top ten urban areas ranked by power capacity contain four areas with ballistic missile defenses in the improved U.S. posture. And the top ten urban areas ranked by POL contain three areas with ballistic missile defense. While a Soviet bottleneck strike with 111 SLMs is not likely, if it were attempted, the improved U.S. posture would dominate the OSD and USAF cases.

SUMMARY

The United States probably could reorganize its economy after a Soviet second strike given any of the three postures --OSD, USAF, and improved U.S. It can be shown that the balance of surviving resources to surviving population for all three U.S. postures would provide at least an austere standard of living if the Soviets delivered a counterurban strike before the U.S. bomber strike, but in such a case there are very great uncertainties about ecology, political and industrial organization, and social behavior, enough to cast doubt on speedy reestablishment of a viable national economy.

Should the Soviets use their residual forces after the U.S. bomber strikes, then the improved U.S. posture dominates OSD and USAF postures with respect to the balance of surviving resources and population and with respect to organizational and social factors. The improved U.S. posture implies that a larger surviving population could have a higher postattack standard of living than in the other two postures. And organizational breakdown ought to be less pronounced in the improved U.S. posture, because absolute losses are less. Consequently, feasible economic possibilities are more likely to be realized in the improved U.S. posture.

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Appendix G

TWO RELIABILITY RETARGETING SCHEMES

THE PROBLEM

SECTION 4 includes a discussion of the importance of ICBM retargeting capability adequate to realize the potential benefits of reliability monitoring and to meet the requirements of flexible force usage from the beginning through the terminal phases of the war. It has been questioned if eight targets per missile is an adequate capability or if some larger number of targets per missile, or even complete retargetability by explicit guidance, is required. One of the possible problems with the constraint of eight targets per missile is that there may be no adequate compromise between force effectiveness and efficiency on the one hand, and operationally usable targeting doctrines on the other.

This Appendix discusses two retargeting schemes to put lower and upper limits on the capabilities of reliability retargeting in the context of attacking a sizable number of identical soft targets where this is the only mission of the missile force involved. The lower limit is defined by a very simple targeting doctrine for a missile force with eight targets per missile. It has been suggested that the simple doctrine would perform almost as well as unlimited retargetability. The upper limit is given by full retargetability.

If it is desired to give alternate missions to the force, either to get some use out of those missiles not actually launched at prime targets or to have the flexibility of other strike options, then additional demands would be placed on missile retargeting capacity. These considerations are not incorporated in the mathematics to follow.

THE MODEL

The mathematical treatment is limited to retargeting on the basis of reliability monitoring against a set of T identical targets with no more than one reliable missile required per target. The monitoring system tells with certainty whether or not each missile launched was reliable.

Many treatments of retargeting deal with the expected forces used (actually launched) in performing a mission with no consideration of the size of the force that must be committed to the mission to handle the random variations in actual force used. This is a tolerable approximation if one is comparing salvo versus retargeting policies, retargeting under different constraints on the number of retargeting cycles (that is, number of "looks"), variations in the quality of the information received in the looks, or different penalties for delay in kills caused by looking.

However, we are interested here in constraints on the number of targets per missile and on the processing to be done to the information gained by monitoring. For this purpose it is necessary to be explicit about the size of the reservoir of missiles involved in the attack and not merely the expected number of missiles used. As an extreme example, with a sufficiently large reservoir of backup missiles, only one target per missile will do essentially as well as any other system. Many missiles are pretargeted to each target, and are fired until one proves reliable. The number of missiles used will be as low as in the unlimited retargeting case. However, the missiles committed, in the sense of being tied up in the reservoir, will be many times as large.

Let N be the size of the reservoir or force committed to destroying the T targets. Attacking this set of targets is the only task of these missiles.

Two targeting doctrines are treated. The first, limited retargeting, is for use with missiles having eight targets per missile and is designed to minimize the processing that the monitoring data must undergo. The targets are divided into T/8 clusters of eight targets each. For each target cluster there is an associated missile cluster of 8N/T missiles.* All missiles in a missile cluster

*Analysis is restricted to values of N and T for which T/8 and 8N/T are integers. Intermediate cases could be handled with appropriate changes yielding intermediate results.

have this same set of eight targets allotted to them. Since there is no interaction from one cluster to another and all missiles within a cluster are identical so far as targeting is concerned, the decisionmaking required is quite simple.

The second targeting doctrine treated, full retargeting, requires, in the pure form treated here, that any of the missiles be able to strike any of the targets: that is, be fully retargetable.* In this scheme, T of the N missiles are launched, one to each target, with some random number S of the missiles aborting, leaving S targets surviving. If S does not exceed the number of remaining missiles, that is, if $S \leq N - T$, then S missiles are launched at the surviving targets. If $S > N - T$ then all remaining missiles are fired at surviving targets. The process is repeated until either all targets are destroyed or all missiles are used up.

With limited retargetability it is possible that missiles in one missile cluster will be exhausted without killing all the associated targets. Even though there may be missiles left over in other missile clusters, they cannot be used against these surviving targets. Such is not the case with full retargeting where either all missiles are exhausted or all targets are destroyed.

Targeting doctrines undoubtedly exist for a force with eight targets per missile that are of greater intricacy and that would do better than our limited retargeting. No analysis is attempted here of how much improvement could be realized with reasonable complexity. Hence, any inadequacies of our limited retargeting doctrine cannot, without further analysis, be interpreted as inadequacies of a force with eight targets per missile. However, at the minimum, the necessity for more subtle analysis of retargeting will be pointed out.

Our full retargeting case accepts no restraints on data processing. As stated, it implies a central processing of all data on missile aborts. Other arrangements are conceivable that would yield the same flexibility with less dependence on central data processing. For instance, all missiles could be clustered exactly as in the limited retargeting scheme. However, a hierarchy of higher level clusterings could be instituted (the hierarchy could be the normal organizational lines -- flight, squadron, wing, force). All retargeting would be handled at

*In the context of the model, which ignores questions of missile readiness, the T missiles launched first could be pretargeted. In actual operations, however, it would probably be desirable for them to have some retargeting capability.

the lower levels unless lower echelons came up with either unused missiles (all their targets destroyed) or unattacked targets (all their missilas used up). It would be just in those circumstances where the limited retargeting scheme would fail to cover all targets in a cluster that the higher echelons would be called upon to assign targets.

OUTCOME DISTRIBUTIONS

For given values of N, T, and missile reliability, r. we are interested in knowing the performance of the retargeting doctrines. However. it is risky to pick some index of the outcome without first having an understanding of how the outcome might vary due to chance. In other words, we should look at the frequency distribution of outcomes.

Figures G-1 through G-4 are plots of the probability that the fraction of targets surviving will equal or exceed a given amount for limited and unlimited retargeting, for reliabilities of 0.5 and 0.8, and for different ratios of missiles to targets (N/T) for the case of 800 targets. The dashed lines are the outcome distributions for the salvo case using the same forces. The means by which these curves were constructed is presented in the last section of this appendix.

In Fig. G-1 the ratio of missiles to targets is 1.25. In the limited retargeting case this corresponds to clusters of 10 missiles for 8 targets.

Consider the r = 0.8 curves of Fig. G-1. This is a threshold case in that the expected number of reliable missiles just equals the expected number of targets. For r = 0.8 and at probability levels above .5, unlimited retargeting kills about 4 to 6 per cent more targets than does limited retargeting. If one were to attempt to make a cost-effectiveness comparison by taking the ratio of expected targets destroyed to missiles committed. the two retargeting schemes would thus differ by only 5 per cent. But such a calculation can be quite inappropriate. Notice that the unlimited retargeting scheme has a fairly high (0.74) probability of reducing survivors to one per cent or less of the original force and a 50 per cent probability of destroying all targets, while with the limited retargeting scheme there is almost no chance (0.02 probability) of reducing surviving targets to less than 3 per cent of the original force. Whether such differences are significant depends upon the context in which the targets are attacked. Under some circumstances it

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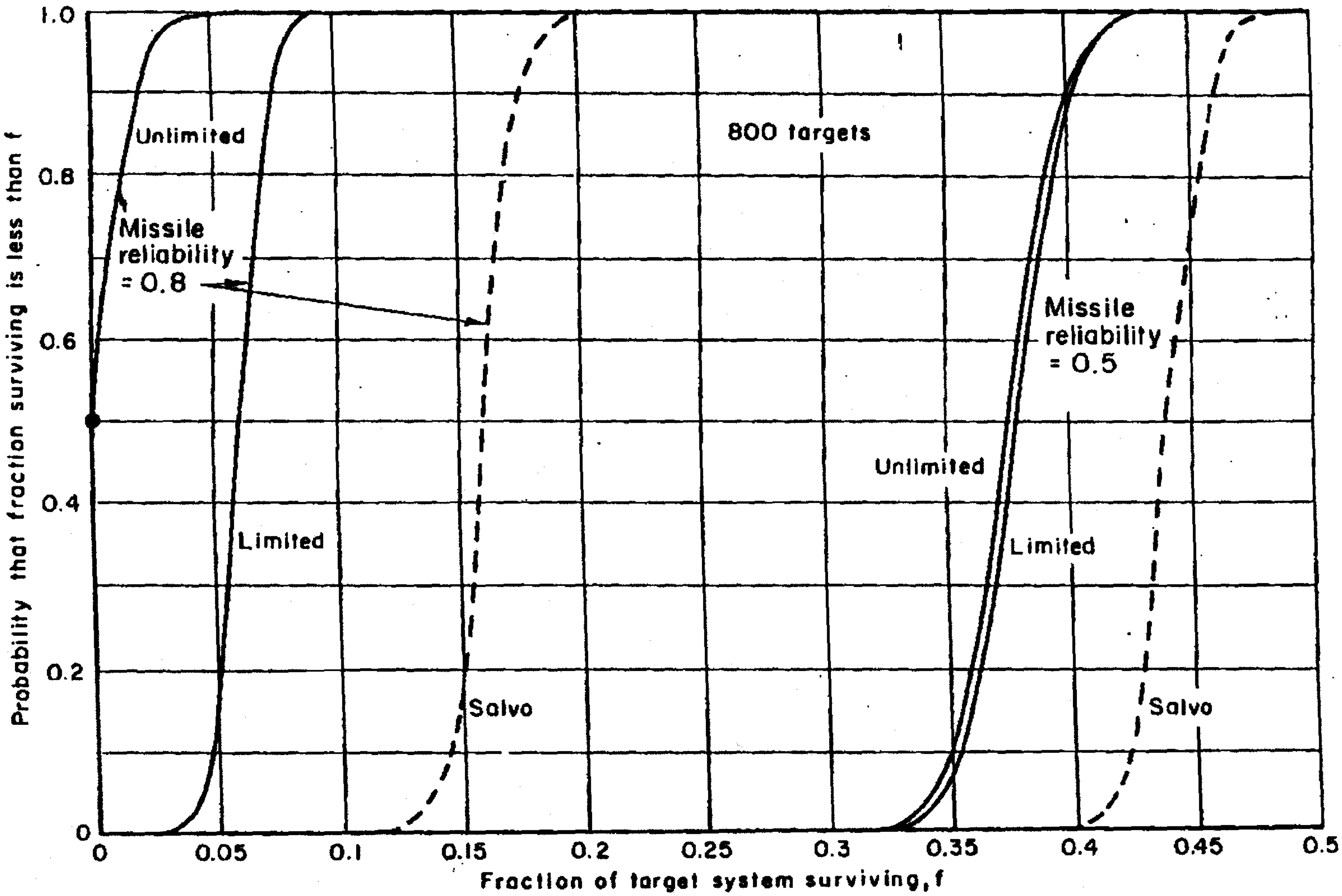

Fig. G-1 — The effect of variation in retargeting flexibility — 1.25 missiles/target

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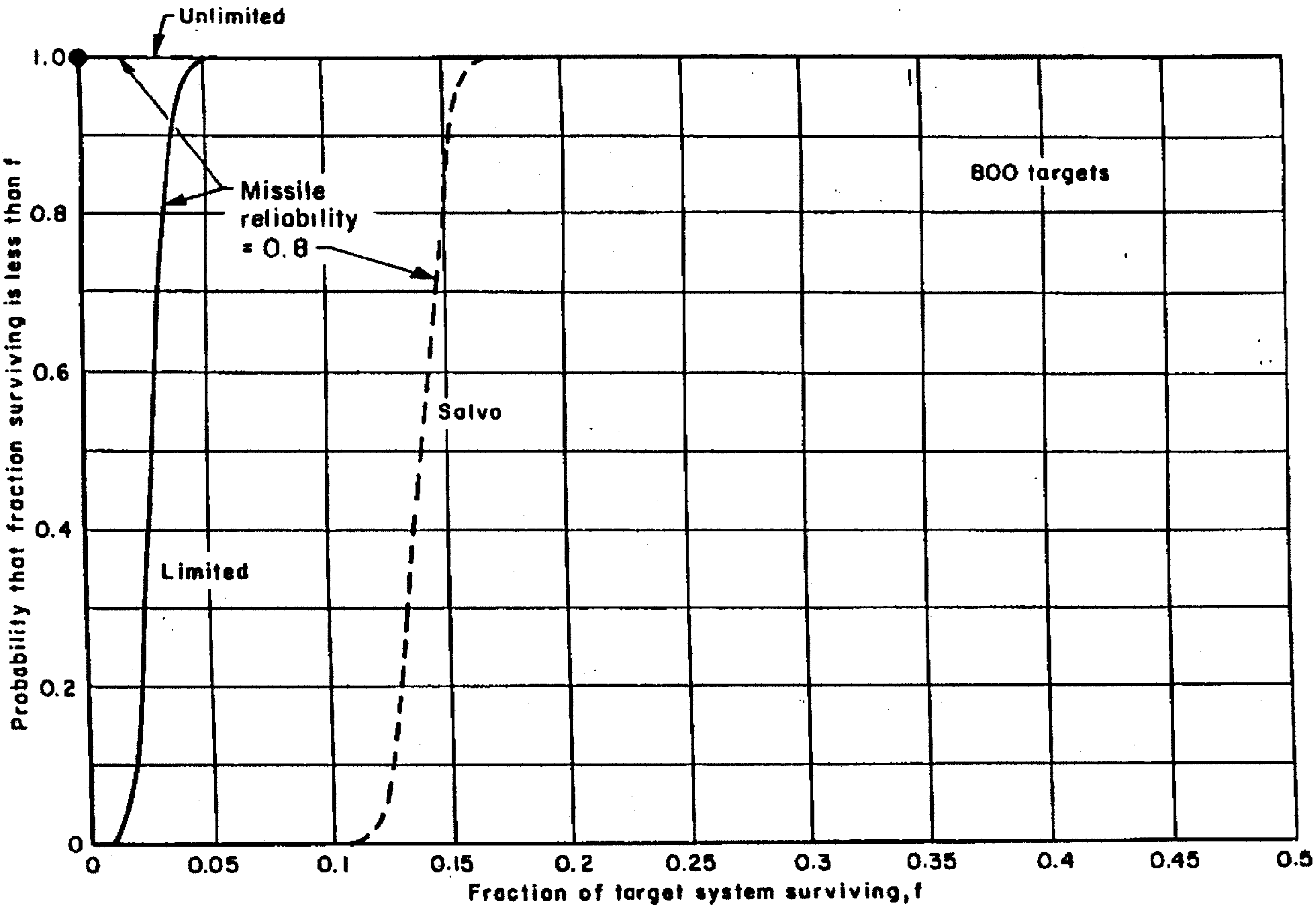

Fig. G-2 — The effect of variation in retargeting flexibility — 1.375 missiles/target

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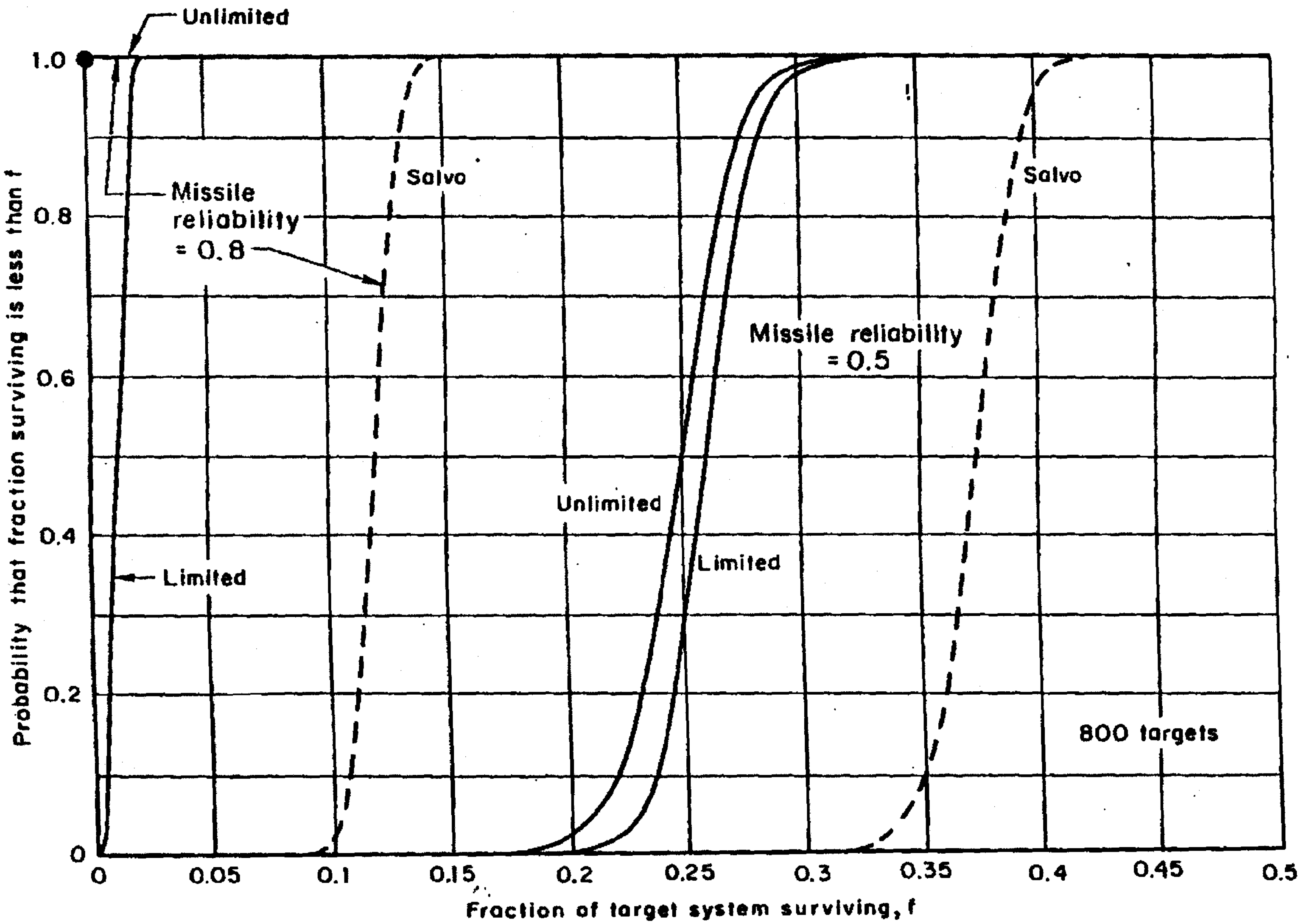

Fig. G-3 — The effect of variation in retargeting flexibility — 1.5 missiles/target

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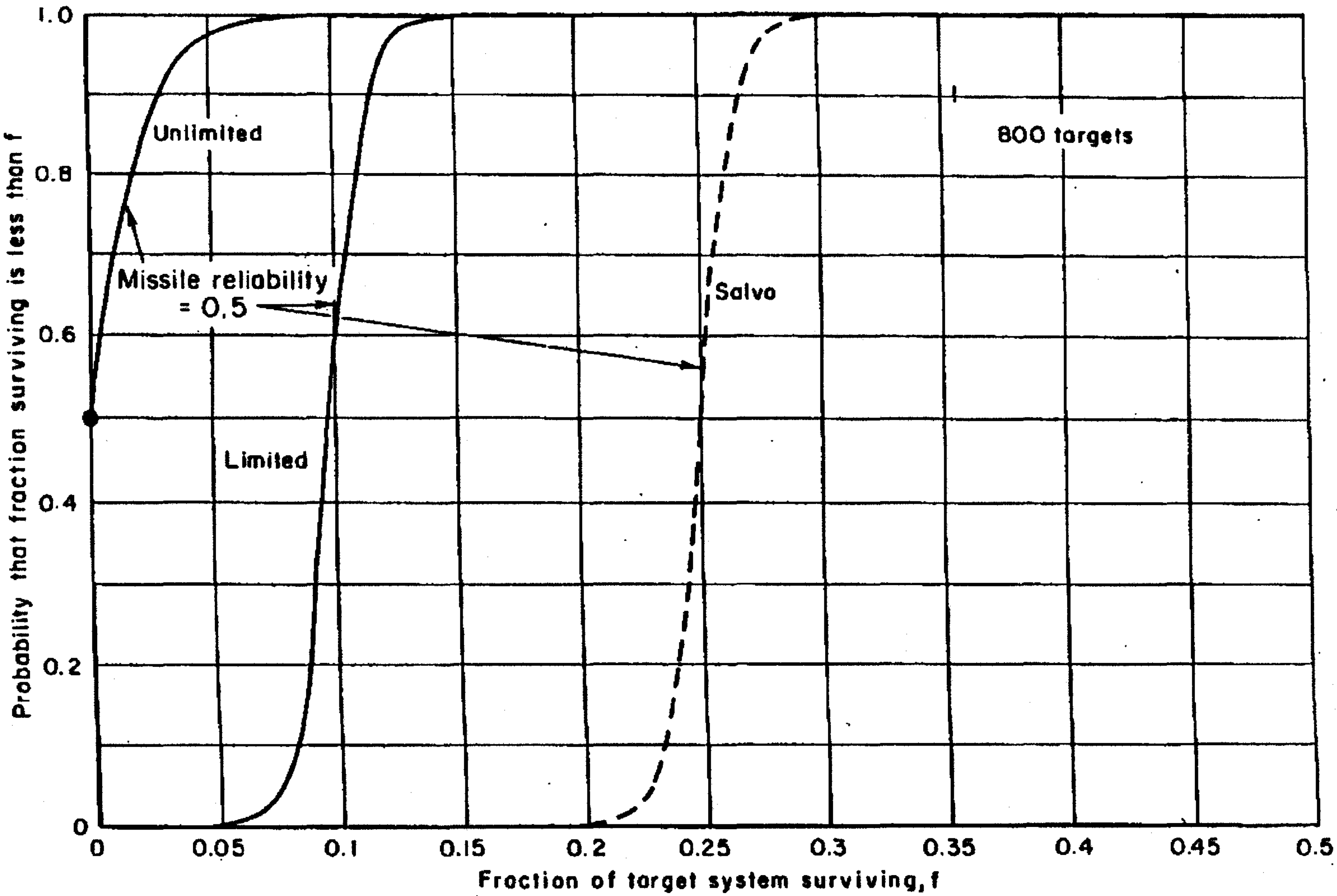

Fig. G-4 — The effect of variation in retargeting flexibility — 2 missiles/target

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could be very useful to kill the last target. in other circumstances it would not be so important. In short, conclusions on the relative merit of the two schemes will be sensitive to the criteria used, and care must be taken that these are appropriate to the context. The more demanding the requirement on fraction of targets surviving, the greater will be the difference.

If performance like that of the limited retargeting at the 0.8 reliability curve of Fig. G-1 is satisfactory, a reduction in the missile-to-target ratio of about 6 per cent would lead to an unlimited retargeting distribution curve fairly closely matching that of the limited targeting curve shown. In other words. under these circumstances. unlimited retargeting can do the same job with a 6 per cent smaller force.

Suppose that it is desired to match the performance of the unlimited retargeting curve (at 0.8 reliability) in Fig. G-1 by using limited retargeting and a larger force. To get a comparable case it is necessary to go to the case shown in Fig. G-3. 1.5 missiles per target (12 missiles per cluster), a 20 per cent increase in the missile force. Then one gets a better performance in the high confidence regions (.8 probability or higher) but there is still only a slight probability of killing all targets. Note that at this level of force the unlimited retargeting case yields virtual certainty of leaving no survivors. In fact. this is also the case of the smaller force of Fig. G-2. As can be seen from these cases. performance of unlimited retargeting is very sensitive to the ratio of number of expected reliable missiles to number of targets when this ratio is near 1.

Suppose that the reliability is 0.5 instead of 0.8. Now the missile-to-target ratios of Figs. G-1 through G-3 are such that the expected number of reliable missiles is well below the number of targets. In these cases neither retargeting scheme performs well and there is not much difference between the two.

When the ratio of missiles to targets is increased to 2 to give an expected number of reliable missiles equal to number of targets at 0.5 reliability (Fig. G-4), noteworthy differences between the two schemes appear again. Expected survivors are 10 per cent and 2 per cent for the limited and unlimited cases respectively. with again a 50 per cent chance of killing all targets for the unlimited case. An increase in the force to 2.2 missiles per target would raise the probability of killing all targets to about 0.98 for the unlimited case.

EFFECT OF UNCERTAINTY IN RELIABILITY

So far the discussion has been made as if the reliability were precisely known. There will be significant uncertainties in this parameter for a first-strike force and they would presumably be quite large in the second-strike case. Moreover, force commitment would have to be made without knowing which case would arise.

One effect of uncertainty in the reliability factor would be to blur the distinction between the two retargeting schemes, within the context of this model.* If planning factor reliability were quoted as 0.8, a wise planner using full retargeting would not make the razor thin decision of allocating at the level of 1.375 missiles per target. If he properly includes in his definition of confidence the possibility of variations in the reliability parameter, he may have to increase the allocation to, say, two to one to achieve a reasonably high confidence of satisfactory performance.

THE FATE OF UNUSED MISSILES

Unused missiles are to be expected under most circumstances using these retargeting schemes. Other things equal, there will be more unused missiles for limited than for unlimited retargeting. If the missile-to-target ratio has been chosen to give high performance or to hedge against low reliability the expected number of unused missiles could be very large.

Design and evaluation of retargeting schemes should take unused missiles into account. These missiles could be useful provided alternate targeting could be effected. This would seem to be most simply handled with the explicit guidance systems. For the case of eight targets to a missile, alternate targeting might not be possible except after a period of several days or weeks, unless, say, only six target slots were used for primary targets. The two remaining slots would be used for back-up targets (such as [redacted] where high assurance of delivery might not be necessary. Such an allocation would force a change in the above analysis for the primary targets since there would then be fewer than eight targets in a cluster.

*See, however, the discussion of unused missiles below.

CONSTRUCTION AND FURTHER DISCUSSION OF THE DISTRIBUTION CURVES

Construction of the distribution curves is most simply handled with the unlimited retargeting case. The important random variable is the number of missiles that are, or would prove to be, reliable. If this number is greater than or equal to T, then all T targets are destroyed: otherwise the number destroyed equals the number of reliable missiles. The frequency distribution of the number of reliable missiles is binomial with mean $\mu_m = Nr$ and standard deviation $\sigma_m = \left[Nr\ (1 - r)\right]^{\frac{1}{2}}$. Figure G-5 is a schematic of the distribution of number of reliable missiles expressed cumulatively as the probability that at least n missiles are reliable.

The cumulative distribution for targets destroyed will be identical to that of number of reliable missiles except it will be truncated at n = T. The mean and standard deviation of the reliable missile distribution are not the mean and standard deviation of the distribution of targets destroyed. They are, however, convenient parameters for understanding the behavior of full retargeting.

Figure G-6 is a schematic of the cumulative distributions of targets destroyed expressed in terms of fraction of targets for different values of μ_m/T and σ_m/T. These are just the cumulative distributions of reliable missiles truncated when n = T (solid curves). For curves 1 and 2 the expected number of reliable missiles just equals T. The probability of destroying all T missiles is 0.5 in this case no matter what σ_m may be. However, decreasing σ_m brings, say, the fraction destroyed for which one has a 90 per cent confidence closer to 1. If μ_m is increased slightly beyond T through increasing the missile allocation or through increased reliability, then the probability of destroying all targets can become quite high and is sensitive not only to μ_m/T but also to σ_m/T, as can be seen by comparing curves 2 and 3.

The analysis of the limited retargeting case begins with a single pair of target and missile clusters. Each cluster pair is a small-scale example of full retargeting; in particular, the frequency distribution for the number of reliable missiles in a cluster is binomial and that for targets destroyed is formed by a suitable "truncation" of this distribution. The mean μ_o and standard deviation σ_o of the targets destroyed for an individual cluster pair were calculated directly with the aid of tables of the binomial distribution. Letting C be the number of

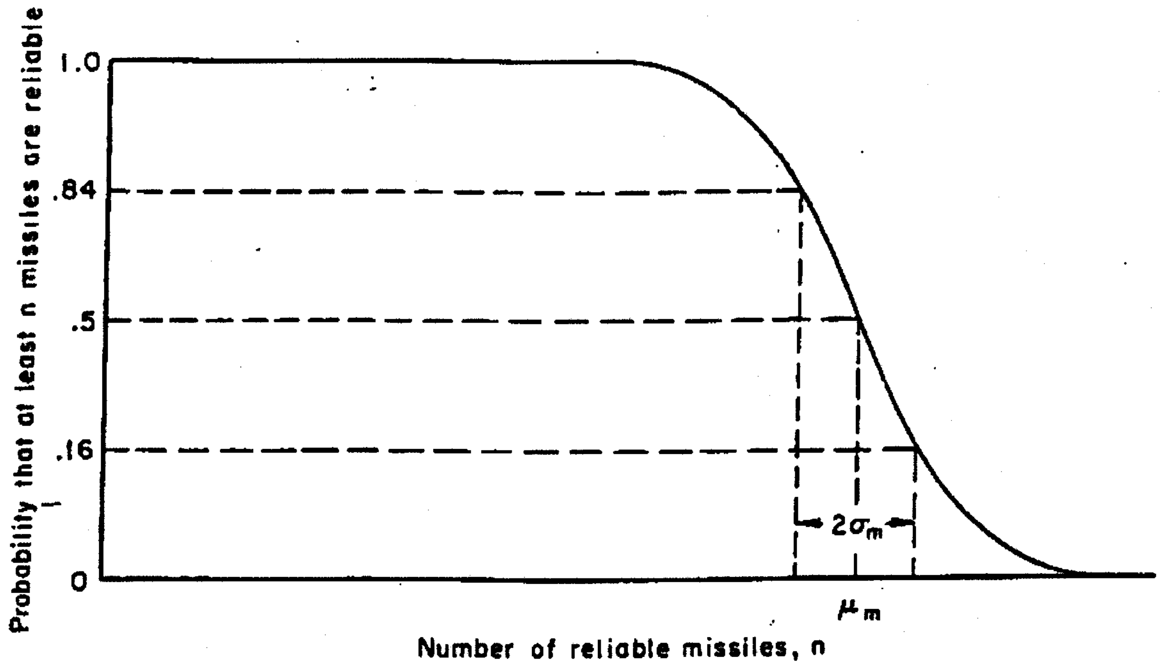

Fig. G-5 — Schematic of distribution of reliable missiles

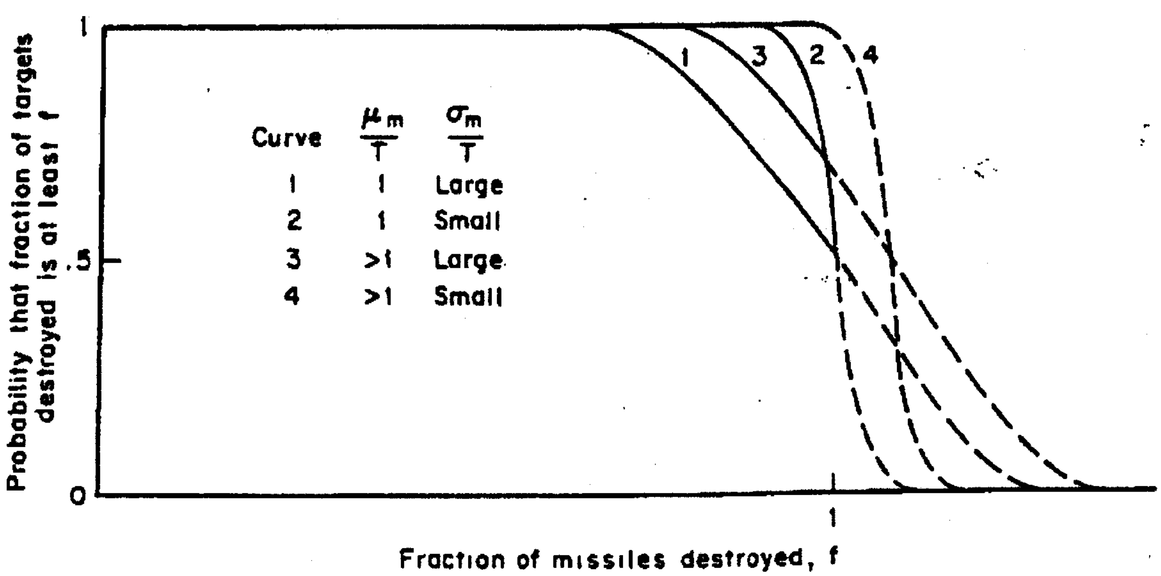

Fig. G-6 — Schematic distributions of targets destroyed—full retargeting clusters $(C = T/8)$, the mean and standard deviation for the target system as a whole were computed as $\mu = C\mu_o$, $\sigma = \sqrt{C}\sigma_o$, respectively. Although the effect of truncation and the small number of targets per cluster make the frequency distribution for individual clusters highly non-normal, the distribution for the targets as a whole, being made up of the additive effect of many individual and independent clusters, approaches the normal for large enough T. Hence, we have drawn the cumulative distribution of the fraction of total targets destroyed for the limited retargeting case as if it were normal, using the mean and standard deviation computed as stated above.

For fixed N/T and r, varying T changes σ_m and σ inversely with the $\sqrt{T}$. Thus, the effect of using, say, only 200 targets would be to reduce the slopes of the curves of Figs. G-1 through G-4 by a factor of 2 with the .50 probability point remaining fixed. In some of the unlimited retargeting cases this .50 probability point lies on the extension of the curve beyond zero missiles surviving; that is, into the region corresponding to the dashed lines of Fig. G-6. Care must be used in treating lower values of T because the normal approximation becomes poorer as T is decreased.

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